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ACIDIC PRECIPITATION IN ONTARIO STUDY

TECHNICAL AND OPERATING MANUAL APIOS DEPOSITION MONITORING PROGRAM

(1st Revised Edition)

ARB-082-87-AQM

APIOS-003-87

APRIL 1987

Ontario
Ministry of the Environment

E. PICHÉ, Director
Air Resources Branch

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1.0 INTRODUCTION

The overall mandate of the Acidic Precipitation in Ontario Study (APIOS) is to protect Ontario's environment from the detrimental effects of acidic precipitation and of other air pollutants which are subject to long range transport. The atmospheric deposition program in APIOS plays a vital role in Ontario's ongoing research to determine the quantity, acidic concentrations, and impact of acid rain and snow, as well as dry particulate matter, falling in sensitive areas and other parts of the Province.

The atmospheric deposition program consists of two monitoring networks, a cumulative (28 day) and an event (daily) network. This manual has been prepared to document these networks' operating procedures to guide personnel in carrying out their respective duties and responsibilities. The objective of these procedures is to ensure that the reported data are complete, precise, accurate, and representative. Quality control and quality assurance procedures have been described throughout the manual. Detailed quality assurance procedures are available in a separate quality assurance manual (1). All figures and tables are contained in an accompanying appendix.

2.0 DESCRIPTION OF NETWORKS

The Air Resources Branch currently operates two networks under the auspices of the Acidic Precipitation in Ontario Study (APIOS). Both networks are designed with the general objective of quantifying wet and dry deposition across the Province of Ontario. These networks are the APIOS Cumulative Wet/Dry Deposition Network and the APIOS Event Wet/Dry Deposition Network. The cumulative network collects samples on a 28-day cycle (monthly basis since the network inception to December, 1981) for the determination of long term wet/dry deposition patterns; the event network collects precipitation and air filter samples on a daily basis for the determination of both wet and dry short term deposition.

It should be emphasized that since both networks measure deposition, the difference between the two is related to the sampling period. Specifically, event (used interchangeably with the term daily) sampling allows one to investigate the characteristics of deposition events and to determine the origin of the pollutants deposited in these events. Cumulative sampling, on the other hand, provides information only on long term deposition patterns. The instrumentation employed in these networks is described in Section 4.2 "Instrumentation and Sampling Methods".

2.1 Event Network

The Event Wet/Dry Deposition Network consists of two components - one for the measurement of wet deposition and the other for the measurement of dry deposition. The following sections provide an overview of these two components.

2.1.1 Event Precipitation Network

The objectives of this precipitation network are twofold:

1) To study the chemical composition, frequency and intensity of acidic precipitation episodes in the province.

2) To determine the wet deposition of acid - related materials associated with air masses originating from different directions and, hence, from different emission source regions.

Four general areas of Ontario were chosen for the sampling program, namely the London, Kingston, Dorset and Atikokan areas. The first three areas are aligned along the prevailing wind flow direction for the southern part of Ontario and have significant levels of precipitation acidity (based on historical data). Dorset is an area of known acid sensitive lakes and is the focus of a great deal of study; London and Kingston, being located close to the United States border, can be used to determine directly the amount of deposition associated with these emissions. The Atikokan area was chosen to monitor background concentrations of pollutants prior to the start-up of a coal-fired generating station at Atikokan. As well, within the zone of influence of the Atikokan generator lie the acid-sensitive lakes of the Boundary Waters Canoe Area of northern Minnesota.

Each of these sampling areas is designed to have 4 event precipitation collection sites. The 4 sites within each area are separated into 2 groups of 2 sites each. Between each group is to be a distance of 50 to 100 km. Within each group, the samplers are to be 5 to 10 km apart. Site locations are presented in Figure 1 and Table 1.

2.1.2 Event Air Sampling Network

The objectives of this air sampling network are two-fold:

1) To determine the amount and origin of airborne acid-related pollutants available for deposition in Ontario on a daily basis.
2) To estimate dry deposition rates of these pollutants on a daily basis by using the airborne concentrations and appropriate deposition velocity values in the relationship: depostion rate = deposition velocity x concentration.

One of the daily precipitation monitoring sites in each of the London, Kingston, Dorset and Atikokan areas is chosen as a daily Dry Deposition Network site. The number of samplers in each region is significantly smaller than that for precipitation sampling because of smaller spatial variability in air quality data. Site locations are shown in Figure 1 and Table 1.

2.2 Cumulative Network

The cumulative network monitors on a 28 day cycle collecting precipitation and air filter samples to measure long-term wet and dry deposition. The following sections provide overviews of these components.

2.2.1 Cumulative Precipitation Network

The objectives of this precipitation network are:

1) To study the chemical composition of cumulative precipitation samples (collected on a 28-day cycle) within the Province.

2) To determine the long-term wet deposition distributions of various chemical parameters (both temporally and spatially) across the Province.

The sampling program is conducted in five of the Ministry of the Environment's regions (regional office locations in parentheses): The Southwestern region (London), encompassing the West-Central region; the Central region (Dorset); the Southeastern region (Kingston); the Northeastern region (Sudbury); the Northwestern region (Thunder Bay). Because the steepest gradients in deposition exist in southern Ontario, the density of samplers is highest there. Site locations are provided in Figure 2 and Table 2.

2.2.2 Cumulative Dry Deposition Network

The objectives of this network are also two-fold:

1) To determine the ambient concentration of airborne acid-related pollutants on a cumulative (28-day) basis.

2) To infer dry deposition by using airborne concentrations (obtained by low-volume air sampling) with appropriate deposition velocity values in the relationship:

deposition rate = deposition velocity x concentration.

Based on these estimates, the long-term dry deposition distributions of various chemical parameters (both temporally and spatially) across the province can be derived. The number of low-volume air samplers in each region is slightly less than those of the precipitation collectors because of smaller spatial variability in air quality data. Site locations are shown in Figure 2 and Table 2.

3.0 ORGANIZATIONAL STRUCTURE

An organizational chart is shown in Figure 3 displaying staff relationships, lines of authority, and responsibilities. The deposition studies are undertaken by the Atmospheric Processes Unit which is part of the Air Quality and Meteorology Section of the Air Resources Branch. Each position in the organizational chart is listed below along with a brief description of responsibilities and duties as they relate to the APIOS monitoring program.

Air Quality and Meteorology Section Manager

- oversees management of the Atmospheric Processes Unit's program.

Atmospheric Processes Unit Head

- program planning, supervision and review
- budget approval and review
- external program representation
- scientific program guidance within Branch
- public relations as required

Atmospheric Deposition and Chemistry Program Coordinator

- scientific direction and supervision of program staff
- overall responsibility for all aspects of atmospheric deposition and chemistry program
- program and budget planning
- responsibility for program report preparation
- maintain scientific profile of program outside of Branch
- quality assurance manager

Data Analyst

- advanced data analysis
- report preparation
- scientific information exchange

Database Scientist

- database development and maintenance
- production of data reports, statistical data summaries
- supervision of interfacing and data exchange with other networks

Technical Co-ordinator

- oversee all network operations
- supervision of special studies in the areas of instrument development, evaluation, and intercomparison
- quality assurance co-ordinator
- preparation of quality assurance and network assessment reports

Project Scientists - Laboratory

- liaison between laboratory operations and monitoring program

Special Studies Scientist

- conduct and preparation of reports of all special studies
- support of quality assurance
- support of network operations

Environmental Technicians (Regions)

- installation, operation and maintenance of monitoring networks
- liaison with network operators
- execution of special studies as required

Environmental Technician (Toronto)

- sample coordinator, submission of all samples to laboratory
- filter preparations
- supplies ordering, inventory maintenance
- support of special studies and network operations

Note: The environmental technicians in the regional offices are regional technicians supervised by regional Senior Technicians or Air Quality Chiefs.

4.0 FIELD OPERATIONS

The following sections describe the technical and operating procedures to be used in the APIOS field program. In each type of network, the operator and environmental technician procedures are separately described. All personnel should be thoroughly trained on these procedures to ensure that standardized operating procedures are followed. For details on training requirements see the quality assurance manual (1).

4.1 Site Selection Criteria

The importance of choosing a representative monitoring site is crucial. Every potential site or existing site is to be evaluated for its representativeness(1). A site is considered non-representative if any local sources of contamination affect the chemistry of the sample, or if the site's location influences (either increases or decreases) the precipitation amount collected. The following site criteria are to be used for locating (or evaluating) APIOS monitoring sites. These criteria are based on the Long Range Transport of Air Pollutants (LRTAP) task force recommendations (2).

1. There should be no continuous sources of emissions (anthropogenic) within 50 km of the site.

2. There should be minimal (preferably none) sources of pollution (air, water, surface transportation), surface storage sources of pollution (sewage plants, landfill sites, fuel depots), or wind activated sources (cultivated fields, sand or salt piles, etc.) within 1 km of the site.

3. The sampler should be located on good ground cover (preferably grass covered) and no object should be located within 5 meters of the sampler which extends above the height of the sampler.

4. The sampler should be located at a distance of at least 2.5 times the height of any object.

5. The site must be accessible to an AC power supply. The site must also be easily accessible for an operator or technician year-round. The susceptibility to vandalism should be considered.

6. There must be an operator on-site or very nearby to collect samples when required. The interest and attitude of this operator is important in assessing the suitability of the site.

7. The site should have surrounding windbreaks which conform to criteria in number 4.

The above siting criteria should be used as the major criteria for the selection of APIOS sites. It is recognized that some sites may deviate from some of these criteria. In these instances, the deviations must be documented and the possible effects evaluated. All sites will be visited by at least two members of the APIOS program before a decision can be made to select a site for operation. All network sites are to be re-evaluated on a yearly basis to maintain representativeness. Procedures to carry out this evaluation are in the Quality Assurance Manual[1]. The areas that have been found useful to consider for locating sites are:

Parks:

Conservation areas, provincial and federal parks generally have been found to be ideal for monitoring sites. One of the major problems, however, is whether the park is maintained year round.

Pumping Stations, Water Plants:

These locations are advantageous if they meet siting criteria because they are maintained continuously by Ministry of the Environment staff.

Institutions:

Retirement Homes, regional centres, and schools are found to be good sites because someone is usually on site continuously. However, problems can arise due to vandalism and public usage.

Private Property:

Usually the last avenue to be explored because of the variability and uniqueness of each location. Each location and operator should be evaluated for their merits before making a decision.

A site questionnaire (Figure 4) is to be filled out for all monitoring sites in the APIOS networks. This questionnaire is also to be used for potential sites and will provide information leading to the acceptance or rejection of any proposed sites.

4.2 Instrumentation and Sampling Methods

This section describes the instrumentation and sampling methods employed in the monitoring networks.

4.2.1 Event Network

Both the event precipitation and air sampling network sample on a daily basis (0800 hrs local time). The precipitation network uses wet-only precipitation collectors and the air sampling network employs sequential air samplers.

4.2.1.1 Precipitation Measurements

Instrumentation:

Aerochem Metrics precipitation collectors, with teflon coated hood and arms, and polyethylene/foam hood gaskets. The precipitation sensor of the collector is modified to encorporate a sensor identical to that of the M.I.C. Type A precipitator collector (see below).

Collection Vessel:

Polyethylene/nylon laminated bags inserted into polyethylene buckets. The collection surface is approximately 1.5 m off the ground.

Precipitation Depth Measurements:

Summer - A.E.S. (Atmospheric Environment Service) type standard rain gauges (mounted approximately ½ m from ground cover)

Winter - Nipher-shielded snow gauges (mounted 2 m from the ground)

4.2.1.2 Air Measurements

Instrumentation:

Metrex Sequential Air Samplers, type SAS8-25. These samplers collect gaseous and particulate pollutants by drawing air (20 lpm) through 47 mm filter packs located on a 10 m tower. The sampler sequences the air flow through 8 channels which are connected via tubing to the filter packs. Filter packs are changed once a week, while one pack remains passive for that week. The volume for each pack is determined by a temperature-compensated dry gas meter coupled with 8 individual total flow digital

counters. An external filter (Gelman Vacushield) is placed in-line between the packs and the instrument to prevent any impregnating solution from damaging the pumps.

Filter Packs:

Modified Millipore Swinnex 47 mm 2-stage filter packs. A 2 um teflon pre-filter (for the collection of particulates) and a 1 um nylon filter (for the collection of nitric acid) are in contact in the first stage. Two impregnated (with K_2CO_3 glycerol) Whatman-41 filters (for the absorption of SO_2) are in contact in the second stage. The filter packs are threaded onto a baseplate which is attached permanently to a sheltered housing.

4.2.2 Cumulative Network

The cumulative network collects precipitation and air samples on a 28-day basis (changed between 0700 and 0900 hrs local time) using M.I.C. Type A wet-only collectors and Metrex low-volume air samplers.

4.2.2.1 Precipitation Measurements

Instrumentation:

M.I.C. Type A wet-only precipitation collectors. The wet side bottom is cut out to allow a long sampling bucket to be used. A polyethylene/foam gasket is attached under the hood to prevent metals contamination and to reduce evaporative effects. The sensitivity of the sensor grids is adjusted to 220 k and the delay time is set at 2 minutes ($\pm$ 30 seconds).

Collection Vessel:

Polyethylene/nylon laminated bags are inserted into the polyethylene buckets. A knife edge collar is attached to the bucket to improve the aerodynamics and reduce evaporative effects. The collection surface is at a height of 2 m.

Precipitation Depth Measurements:

A nipher gauge is used year-round to determine precipitation depths at each site. In the summer, a capping layer of oil is used to prevent evaporation. During the winter sampling period a mixture of 60% methanol-40% ethylene glycol, with a capping layer of oil, is used to prevent freezing and

evaporation. A nipher snow shield is attached to the gauge during the winter sampling period. Depth measurements are taken using a metre stick. Temperature readings of the glycol/methanol solution are taken after every measurement (see Section 4.4.1.2.9) to correct for density changes. The collection surface is located at a height of approximately 2 m.

4.2.2.2 Air Measurements

Instrumentation:

Metrex Low-Volume Air Samplers, Type AS-2. These samplers collect gaseous and particulate pollutants by drawing air at a flow of 2.0 lpm through 2 stage, 47 mm filter packs. The filter packs are sheltered on a support pole at a height of 2 metres and are threaded onto a permanently attached baseplate. The volume sampled is determined by a temperature compensated dry gas meter coupled with a digital volume counter and timer. An external filter (Gelman Vacushield) is placed in-line between the filter pack and instrument to prevent any impregnating solution (used on Whatman 41 filters) from damaging the pump.

Filter Packs:

The same 2-stage filter packs are used as in the daily air sampling network (47 mm open face packs). A Whatman-40 filter replaces the teflon filter used in the daily network to collect particulates. A 1 um nylon filter (to absorb nitric acid) and two impregnated (with $K_2 CO_3$ glycerol) Whatman-41's (to absorb SO_2) complete the loading of the pack.

4.3 Event Network

The following sections describe the standard operating procedures to be used in the event monitoring networks. These procedures have been broken down according to the "Operator" and "Environmental Technician" responsibilities.

4.3.1 Event Precipitation Network

The objective of the event sampling progam is to determine the amount and origin of the acidic components of precipitation falling across Ontario. This is carried out by correlating the precipitation chemistry data with air parcel trajectories. These trajectories are time histories of the air parcel that passed over the collector at the time of precipitation. By following the path of the air parcel backwards in time (using available meteorological data) the origin of the pollutants which contributed to the acidity of the precipitation collected can be determined. To standardize the precipitation data it is necessary for the operators of the event sites to collect the precipitation at the proper time each day i.e., between the hours of 0700 and 0900 hrs, preferably at 0800 hrs (local time).

4.3.1.1 Operator Handling Procedures

Specific operating procedures are provided and must be adhered to in order to collect quality samples. Due to the low concentrations of chemical constituents in precipitation samples, any form of contamination will leave the validity of the results questionable. With this in mind the sample handling methods have been developed in order to collect high quality samples and at the same time be realistic during winter sampling under cold weather conditions.

Every morning between 0700 and 0900 hrs (local time)., the sample bag is to be checked to see if any precipitation has been collected. If there is no precipitation in the bag, check the precipitation gauge for any precipitation. If there is any amount of precipitation in either the bag or in the gauge, the bag must be removed and a new bag inserted. A measurement of the gauge must be recorded, even if it is only a "trace" amount, on an operator sheet and in the operator log book.

The collected sample is then carefully decanted into a polystyrene bottle. Any excess volume is measured in a graduated cylinder and recorded prior to discarding it. The sample bottle is then labelled and stored in a refrigerator. Operator sheets and the on-site log book should be filled out for every precipitation event. Generally, depending on the location of every site, an environmental technician will visit the site once a week to collect the samples and check the instrumentation to verify that it is operating properly.

The realization of the objectives of this study rely heavily on operators to collect samples following standard operating procedures and maintain detailed records. The following pages describe the procedures for operating an event site. On a regular basis the technican responsible for every site will go through the procedures with the operators to ensure that proper procedures are used at all times.

To prevent potential contamination, these operating procedures should be followed with the operator standing on the downwind side of the instrument when removing or inserting new sample bags.

4.3.1.1.1 Removal of Collected Samples

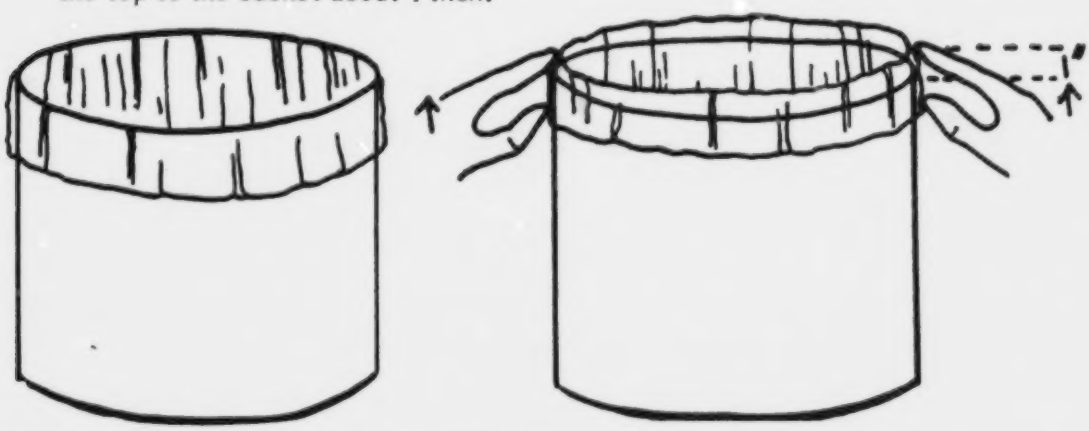
1. Touch the sensor with a wet finger to activate the hood.

2. When the hood has completely rested on the dry side, turn the instrument off.

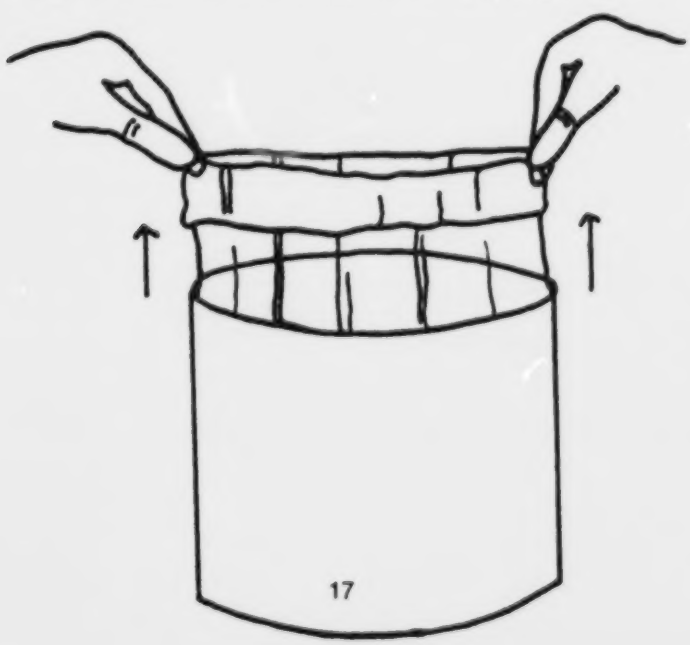
3. Remove the bungy cord from the sample bucket being careful not to lift it over the sample bag (to avoid contamination falling from the cord into the sample bag).

4. Remove the sample bag as follows:

   (i) Gently push the portion of the bag which is outside the bucket up over the top of the bucket about 1 inch.

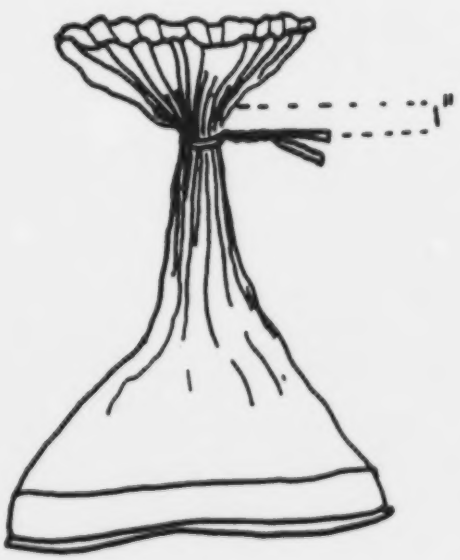


   (ii) Grasp the portion of the bag above the bucket between the thumb and forefinger of each hand and lift the sample bag out.



(iii) Holding the top of the bag with one hand, use the other hand to squeeze the bag just under the fold (approximately 1 inch down from the point where the bag folded over the edge of the bucket).

(iv) Gently squeeze any excess air out of the bag and then tie the bag where it was squeezed in (iii) with a cable tie.



(v) Place the sample bag upright into the supplies box.

4.3.1.1.2 Instrument Cleaning

After the sample bag is removed, wipe the underside of the hood with a Kimwipe wetted with ethanol (in squirt bottle). Rinse with a Kimwipe wetted with distilled deionized water and wipe dry with a new Kimwipe.

Also, once per week using a kimwipe wetted with ethanol, clean the sensor grid. Note: in the winter time only use ethanol to clean the hood and sensor since distilled water will freeze.

4.3.1.1.3 Deployment of New Sample Bags

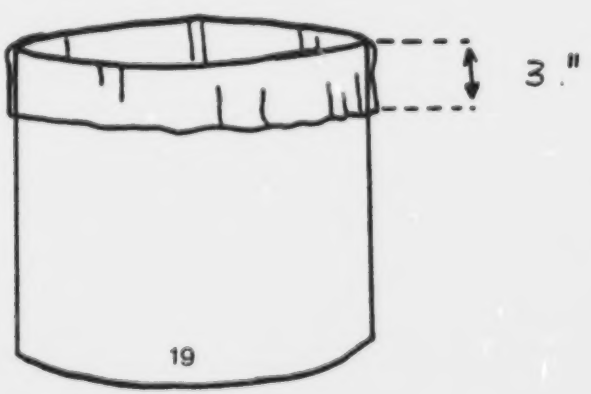
1. Put on a clean pair of disposable plastic gloves. Grasp a clean bag near the top and separate the two halves. Do not place any fingers further than 3 inches into the bag at all times.

2. Placing thumbs inside the bag and fingers outside, shake the bag in air until it has expanded fully.

3. Leave a small amount of air in the bag and squeeze near the top so that the bag is half full of air.

4. Push the bag into the bucket until it hits the bottom (Note: this is necessary to keep the bag partially inflated in order to displace the air in the bucket).

5. Slide the fold over the top of the bucket so that 3 inches of the bag extend down the outside of the bucket.



6. Put on a clean glove being careful not to touch the fingers of the gloves. (Note: It is very important to use a new glove because the next step requires the hand to touch the inside of the bag where precipitation will collect.)

7. Reach into the bag at the rim of the bucket and flatten the bag against the top of the inside wall. Do not shove your hand all the way into the bag, insert it only to the depth of the glove.

8. Secure the bag to the outside of the bucket using the bungy cord supplied. The bungy cord should be attached approximately 2 inches down from the top of the bucket just under the second ridge around the bucket.

9. Turn the power back on. The hood should return to cover the wet bucket with a tight seal.

4.3.1.1.4 Decanting Procedures

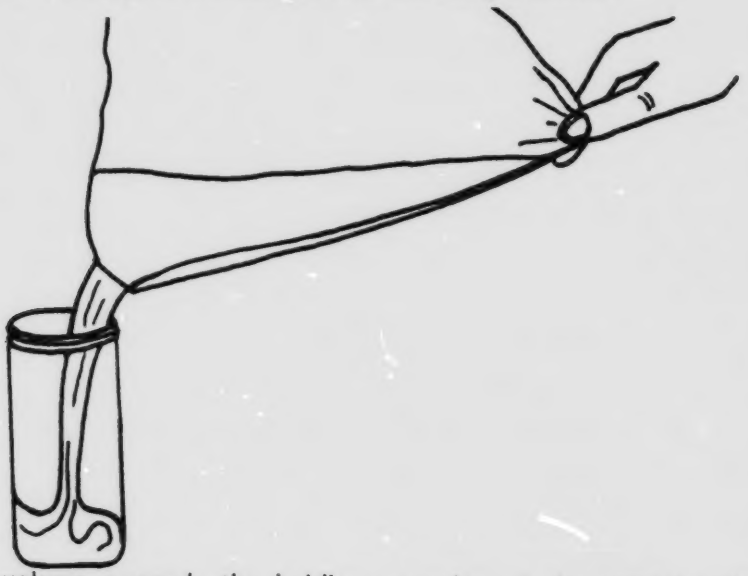
Samples should be decanted in a clean work area to avoid contamination.

1. Bring the sample indoors and place upright on a clean level surface. If the precipitation sample is frozen, allow the sample to melt.

2. Swirl the bag to liberate any particles that may have adhered to the walls of the bag.

3. Take the lid off from one of the polystyrene sample bottles and place the lid upside down being careful not to touch the inside of the lid. Check the bottle for any flaws, cracks, or visible contamination. If the integrity of the bottle is doubted, discard it and use another one. Clean the razor edge of the snips and one bottom corner of the bag with distilled water and a Kimwipe. Wipe both dry with a Kimwipe.

4. Elevate the cleaned corner of the bag and cut it off using the snips. Lower the corner and carefully pour the sample into the sample bottle.



5. If the sample volume exceeds the holding capacity of the sample bottle, measure the rest of the sample in a graduated cylinder and record this excess volume on the operator sample record sheet. Discard the excess volume.

6. Label the bottle with the station name, number, and collection date using the labels provided. Store the sample in a refrigerator for pickup by the technician.

7. Complete an operator sample record sheet (Figure 5) following the procedures outlined in Section 4.3.1.1.9.

4.3.1.1.5 Standard Rain Gauge Procedures (revised March 25, 1985)

This gauge is used to measure the precipitation depth during May to October in the Northwestern region and from April to November in southern regions. The following describes the procedures for recording precipitation depths using this precipitation gauge.

1. The standard rain gauge should be checked for precipitation when the sample bag is checked daily.

2. Gauge measurements should be recorded even if only "trace" amounts are evident. (See step 4). Submit an operator record sheet to the technician with "trace" recorded under the precipitation gauge depth even if no sample was collected.

3. Remove the funnel and cylinder unit from the base. Set the cylinder on a flat surface and measure the depth of the rainfall. The level of water in the plastic graduated cylinder is taken to be that of the lowest part of the curved surface or miniscus. When this lies between two scale marks, the amount is that of the nearer mark. In the case where the level is exactly midway between two scale marks, the amount recorded is the middle value. Note that all measurements will be recorded to the nearest 0.1 mm. Empty the cylinder and put it back in place after the measurement.

4. Whenever the level of the minicus is below the 0.1 mm scale mark, report the value as "trace".

5. In the unusual case where the rainall amount has exceeded the maximum level of the graduated cylinder (25 mm) and has overflowed into the base of the gauge the following should be done:

   (i) Record the level in the cylinder.

   (ii) Discard the precipitation in the cylinder and shake out all possible remaining drops.

   (iii) Empty the contents of the base into the cylinder and measure the level.

   (iv) Add the two measurements together to obtain the total precipitation depth.

   (v) Discard the precipitation.

6. Record the depth of precipitation on the operator sample record sheet.

Note: SPECIAL CASES TO REMEMBER

(i) Freezing Rain - melt at room temperature and then measure the depth.

(ii) Dew - if the amount of dew is measurable, record the level and add the word "dew" on the form.

4.3.1.1.6 Nipher-Shielded Snow Gauge Procedures

This gauge is used to measure the precipitation depth during November to April in the Northwestern region and from December to March in the southern regions.

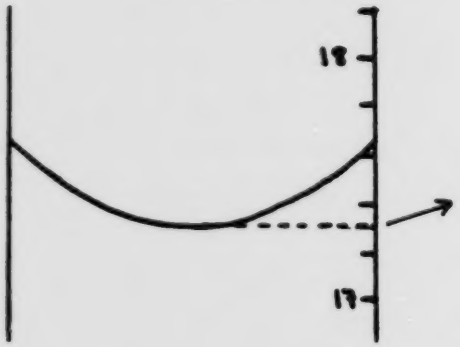
1. The collection cylinder should be checked every morning for precipitation before the Aerochem Metrics sampler is checked.

2. If there is any precipitation in the collection cylinder the cylinder should be carefully removed and then replaced by an empty cylinder (every site operator will have two cylinders).

3. The cylinder should be taken indoors and covered with the cap allowing the precipitation to melt.

4. After melting, the contents should be carefully poured into the calibrated volumetric cylinder using the funnel provided.

5. The measurement should be taken to the nearest 0.1 mm. The lowest part of the curved surface or miniscus, should be used as the measurement level.



6. If the volume exceeds 20.0 mm, the first measurement should be recorded, the volumetric cylinder emptied, shaken dry, and then refilled with the excess and the measurements added together and recorded.

7. Record the total measurement on the operator sample record sheet and site log book.

4.3.1.1.7 Instrument Checks

The Aerochem Metrics precipitation collector has been found to be a reliable instrument requiring few adjustments or repairs. If the instrument does not operate according to the following steps, contact as soon as possible the field technician in your region. (Refer to information Section 4.3.1.1.13.)

1. Touch the sensor with a wet finger. The hood should activate and swing over to expose the wet-side sample bag. The sensor should be warm to the touch.

2. The hood should after 2 minutes (± 30 seconds), return to cover the sample bucket. The hood should contact the bucket and form a tight seal between the foam gasket and the top ridge of the bucket.

The above steps are used to determine whether the instrument is operating properly when it is not precipitating. If it is raining heavily, the instrument should be in the "open" position. If it is only a drizzle or light precipitation, the instrument may oscillate back and forth, and this is normal. However, if the instrument stays open longer than 5 minutes after a precipitation event ends or if it does not open during a precipitation event, notify the field technician as soon as possible (call collect - Section 4.3.1.1.13).

4.3.1.1.8 Operator Log Book

Every monitoring site has an on-site log book maintained by the site operator. This log book will contain sample and site information and will be periodically reviewed by the technician responsible for the site. The log book should be filled in as below. There should be an entry for every day of the year even if it is only to write "no rain yesterday - sunny and warm".

Date	Time	Sample Collected (Yes/No)	Gauge Depth	Type of Sample	Volume (Excess)
June 3/83	0810	No		Sunny and warm yesterday	
June 4/83	0805	Yes	10.3 mm	event from 11:30 to 14:30	102 mls
June 5/83	0830	Yes	22.6 mm	event from 09:30 to 13:45	no excess 2 duplicates
June 6/83	0930	No		no rain yesterday	
June 7/83	0800	Yes		blank bag collected	

Any comments regarding the sample should be entered into the log book. Any changes to the site should be recorded and the corresponding date also. This infomation is very important. During the validation of samples, it is sometimes necessary to determine if anything unusual could have occurred to affect the sample. The log book is the only written record kept of on-site peculiarities or changes and should be maintained thoroughly.

4.3.1.1.9 Operator Sample Record Sheet

All samples must be accompanied by sample record sheets (Figure 5). The following descriptions outline how these sheets are to be filled out.

Every separate sample must have a record sheet filled out for that sample. The only exceptions are duplicate samples. Since the regular and duplicate samples came from the same event, only one sheet is required. Separate sheets must be filled out for field blanks, composites, and co-located samples since the sampling information is unique for these samples.

Station Name: and Number — Enter the name of the site, eg. Longwoods, 1011.

Sample Collected By: — Operator's name

Type of Instrument: — Check off the appropriate instrument type. If the instrument is a designated co-located instrument, check off the "co-located Aerochem Metric" instrument type.

Sampling Start: — Enter the date the new sampling bag was inserted into the collector. Enter the date and time the bag was checked prior to the precipitation event. Indicate whether it was raining or snowing when the sample bag was inserted into the bucket.
Note: For field blank samples the sampling start is the date and time the sampling bag was inserted into the bucket. For composite samples the sampling start is the date indicated on the outside label of the composite.

Sampling End: Enter the date and time the bag was removed after the precipitation event. Indicate whether it was raining or snowing when the sample bag was removed.

Note: For field blank samples the sampling end is the date and time the field blank was removed from the collector. For composite samples the sampling end date is the date and time the composite sample was handled.

Type of Sample Collected:

Regular: Check the type of precipitation which fell into the sample bag. This coding is to be filled in for all regular samples including samples collected by the co-located collector.

Quality Assurance: Check the appropriate heading to indicate whether the samples are field blanks, composites, or duplicates.

Anything Else in Sample: Check as required to indicate any insects, leaves, particles, or fibres that are observed in the regular or quality assurance samples.

Regular Sample Only: This area pertains only to regular samples which include co-located samples. Enter the start and end times of the most predominant event which occurred during the day. If known, enter any secondary event times. Also indicate the intensity of the predominant event. Enter the excess volume (if required) which resulted after decanting the sample into the sample bottles. For duplicate samples, any excess volume after decanting is also entered here. Enter any excess volume after handling the composite sample in this area as well.

Gauge Measurements: Enter the precipitation depth obtained using the gauge. Co-located instruments will have a co-located gauge for precipitation measurements.

Instrumentation

Problems: Enter the dates and times of any precipitation collector malfunctions. If it is not known when the malfunction first occurred, indicate in the "FROM" area the date and time when the malfunction was first noticed. Enter the date and time the malfunction was corrected (if known). Indicate whether any events were missed. If some were missed indicate how many and when they occurred. Indicate whether a sample spilled or leaked by checking the appropriate box. Describe the sampler malfunction if known.

Supplies: If an operator is getting low on any supplies, check what is needed in this section. If the item is needed right away call the technician collect to ensure the item is delivered during their next site visit.

4.3.1.1.10 Procedural Short List

1. Every morning between 0700 and 0900, (preferably at 0800 local time) activate the sampler and check for precipitation in the sampling bag. Check the precipitation gauge for any precipitation collected.

2. If there is any precipitation in the bag, turn the instrument off and remove the sample following the instructions in Section 4.3.1.1.1. If there is none in the bag but some precipitation in the gauge, record that gauge amount on a sample record sheet and replace sampling the bag following the instructions below. Give the record sheet to the technician indicating that a gauge depth was recorded but no sample was collected.

3. Clean the grids and the hood gasket.

4. Insert a new bag into the bucket following the instructions in Section 4.3.1.1.2.

5. Turn the instrument back on and watch to see that the hood completely covers the bucket.

6. Record the depth of the precipitation gauge on the operator sample record sheet and operator log book.

7. Decant the sample into a sample bottle and record the excess volume. Label the bottle and store in a refrigerator. Note: If sufficient excess volume exists, submit a duplicate sample (1 per month).

8. Fill out a sample record sheet and log book recording all information required.

Note: Once every month submit a blank bag for the quality assurance program following Section 4.3.1.1.12. Also, whenever sufficient volume is available to fill an additional sample bottle, submit this second sample bottle as a duplicate sample (Section 4.3.1.1.12.4).

4.3.1.1.11 Supplies

Supplies should be available on site at all times. If an operator is low on any item, indicate on the operator sample record sheet the supplies that are required. If supplies are needed immediately, contact the technician by telephone (collect) and indicate to him the shortage. Every operator should have at least a 1 month's supply of the following:

- ethanol
- distilled water
- Kimwipes
- gloves
- sample bags
- sample bottles
- labels
- sample record sheets

2. An operator should also have:

- a site log book
- a pair of razor snips
- 2 Nipher collection cylinders and a cap
- a Nipher graduated measurement cylinder
- a funnel
- a technical and operating procedures manual
- waterproof pen

4.3.1.1.12 Quality Control/Quality Assurance Procedures

To verify that samples are collected and transported to the laboratory following the proper procedures, and to ensure that these procedures fulfill our quality assurance objectives, specific quality control checks and quality assurance procedures will be carried out on a regular basis.

4.3.1.1.12.1 Procedures Audit

Semi-annually, the environmental technician will ask every operator to go through their procedures to verify that the current procedures are adhered to. The technician will observe the removal and insertion of sample bags as well as the decanting of a sample into a sample bottle. For decanting, the sample need not be a real precipitation sample if one is not available; it can just be tap water poured into a sample bag. After this review, the technician will go through the operating procedures with the operator to ensure that every operator in the network is using standard operating procedures.

4.3.1.1.12.2 Field Blanks

Sample bags are removed when any amount of precipitation has been collected, after which new bags are placed into the collector. However, these new sampling bags will continue to stay in the collector until the next precipitation event occurs, whenever that may be. Therefore, a sample bag can possibly sit in the collector for several days. To determine whether the sample bag collects any dry deposition during these dry periods, a "field blank" is to be collected on a random basis. This field blank is simply a sample bag which has been in the collector for any length of time during periods of no precipitation. The bag is to be removed using normal operating procedures, twist tied, labelled, and picked up by the technician with an accompanying operator sample record sheet.

Since there is no control over when precipitation occurs, every operator is to submit 1 field blank every month. Operators should try to submit field blanks that have been exposed to as many "dry" days as possible. The longer the period the better, since shorter periods are less susceptible to indicate contamination by dry deposition. Try to submit bags that have been exposed for dry periods from 2 to 7

days. To help determine if a bag should be removed or not, listen to weather forecasts on the radio or television. During these periods, it would be beneficial if general comments about the temperature and wind are entered onto the sample record sheet. Strong winds and very hot days are more likely to expose these field blanks to dry contamination, while cool, overcast days with little wind are less susceptible. Therefore, indicate on the sample record sheet comments regarding the weather during the days the field blank was exposed. The sample record sheet is to be coded as a field blank under "Type of Sample Collected". All other information is entered as a normal event sample.

It is crucial that these field blanks have not been exposed to <u>any</u> precipitation, no matter how insignificant it is. Any sample bags exposed to any amount of precipitation should always be submitted as regular samples.

4.3.1.1.12.3 Composite Samples

To assess whether our measurement system is operating properly, samples of known concentrations will be handled by the operator and submitted to the laboratory following standard operating procedures. A composite sample is a sample of precipitation which has been prepared by adding together excess volumes of precipitation samples previously collected and analyzed. The composite is analyzed to determine its new concentration. Any change in concentrations after the chain of handling steps should indicate sample degradation and/or potential contamination.

Technicians will give operators a polyethylene bottle containing approximately 400 mls of composite sample. Operators are to insert a new sample bag into the collector following normal procedures. The composite is to be carefully poured into the sample bag. The sample is to be immediately removed following normal procedures and decanted in a new polystyrene sample bottle. "Composite" should be coded on the operator sample record sheet together with all other relevant information. The sample bottle is labelled with the station name, number, date and the lettering "Composite". This procedure will be carried out quarterly at every event site.

4.3.1.1.12.4 Duplicate Sampling

Regular operating procedures require event samples to be decanted into a polystyrene bottle and any excess volume measured in a graduated cylinder. For duplicate sampling, any excess sample volume will be used to fill an additional sample bottle.

These additional samples are called duplicate samples. After filling a regular sample bottle, determine if there is sufficient excess volume to completely fill another bottle by using a visual judgement. If the operator feels there is sufficient volume, an additional bottle is to be filled. If the judgement was incorrect, completely empty the bottle's contents into the graduated cylinder and measure the excess volume in the usual way. If the judgement was correct, label this bottle as a "Duplicate" with the station name and sampling date on the outside of the bottle. Any other excess volume is measured in the usual way. Indicate on the operator sheet that a duplicate sample is being submitted under "Type of Sample Collected".

4.3.1.1.12.5 Co-located Sampling

At one event site in every region, a co-located sampler and precipitation gauge will be installed. These samples and measurements will provide estimates of overall precision for the measurement system of the event network.

Co-located sampling simply involves installing another precipitation collector beside the existing collector (of the same make and model) and then collecting two samples for every precipitation event. Samples collected from the co-located samplers are to be coded as "co-located sample" under the heading "Type of Instrument" on a separate operator sample record sheet.

4.3.1.1.13 Contact Information

To contact a technician, call collect using the following telephone numbers:

		NAME (Alternate)	TELEPHONE
Northwestern Region	-	Mr. Wim Smits (D. Griffin) Thunder Bay Regional Office P.O. Box 5000 435 James St. S. Thunder Bay, Ontario P7C 5G6	(807) 475-1215
Northeastern Region	-	Mr. Wilf Tremblay (B. Trayling) Sudbury Regional Office 199 Larch St., 11th Floor Sudbury, Ontario P3E 5P9	(705) 675-4501
Central Region	-	Mr. J.P. Varto (or Contact Head Office) Dorset Research Facility P.O. Box 39 Dorset, Ontario P0A 1E0	(705) 766-2412
Southeastern Region	-	Mr. Steve Elliott (S. MacBeth) Kingston Regional Office 133 Dalton Street, P.O. Box 820 Kingston, Ontario K7L 4X6	(613) 549-4000
Southwestern Region	-	Mr. Joe Alves (G. Grosse) London Regional Office 985 Adelaide St. S. London, Ontario N6E 1V3	(519) 661-2200
Head Office	-	Mr. Bill Bardswick (N. Reid) Air Resources Branch 880 Bay St., 4th Floor Toronto, Ontario M5S 1Z8	(416) 965-1634

4.3.1.2 Environmental Technician Procedures

The following procedures are to be used to collect and submit samples in the event precipitation monitoring network. Technicians should visit these sites once a week.

4.3.1.2.1 Instrument Checks

The instruments installed at every event precipitation sampling site should be checked during every visit to the site. The following checks are to be carried out to determine if the instrument or gauge is operating properly.

Aerochem Metrics Precipitation Collector

1. The precipitation collector should be kept level at all times. Place a level over the North-South and East-West axes on the wet side bucket to ensure that the collection surface is level. Use a clean polyethylene bag to cover the sample to avoid contaminant prior to placing the level on the bucket.

2. Activate the sampler using a wet finger. The hood should move to cover the dry side. After 2 minutes ($\pm$ 30 secs.) the hood should return to cover the wet bucket. Check to see that the hood gasket forms a tight seal over the wet bucket.

3. The hood gasket and sensor head should be checked for cleanliness and the electrical wiring and ground fault breaker tested every visit to the site.

Standard Rain Gauge

1. The rain gauge should be mounted firmly and the funnel rim should be level at all times. Verify by placing a level over the North-South and East-West axes points on the collection surface.

2. The rain gauge should also be free of obstructions such as tall grass, shrubs, trees, and other monitoring instruments. Follow the 2.5 x height rule and Section 4.1 "Site Selection Criteria", to ensure it is properly sited.

3. The funnel and measuring cylinder should be kept clean at all times. Clean when necessary using detergent, warm water and a brush (replace funnel with a spare and clean later at the regional office).

Nipher - Shielded Snow Gauge

1. The snow gauge should be level and anchored firmly. Verify by using a level over the shield and collection cylinder.

2. The snow gauge should be properly sited following Section 4.1 and the collection cylinder should be kept clean.

3. Check to see that the collection cylinder is properly seated in the nipher - shield. The top of the collection cylinder should be flush with the top of the nipher shield.

4.3.1.2.2 Log Books

An operator log book should be maintained by the operator for every sampling site in the network. Ensure that the operator maintains this log book and follows procedures set out in Section 4.3.1.1.8.

An instrument log book is to be maintained by regional technicians for every instrument in the network. The instrument log book is to be filled out after every visit to the site and a copy is to be sent to the head office when a sheet has been completed. Calibration sheets are to remain permanently in the log book. Copies of these calibration sheets are to be sent to the Technical Co-ordinator. All information regarding instrument malfunctions, repairs, instrument checks and preventive maintenance should be entered into the log book. The log book is to be kept with the instrument when shipping for major repairs and overhauls. All copies of previous entries are to be kept in the log. Copies may be made and kept on file for the technicians use. Examples of the log book format are shown in Figures 6 to 9.

4.3.1.2.3 Supplies

Supplies are maintained in the regional offices by the use of a 6 month supplies requisition. The technician will fill out a requisition every 6 months indicating the supplies and spare parts that are required. Any equipment or supplies not listed on the requisition can be bought on local petty cash or by a puchase order put through by head office. Any other request for supplies, especially verbal requests, should always be followed up by submitting the request on a speedy memo. Technicians should have a 6 month supply of operator's supplies and spare parts at all times. An example of the supplies requisition is shown in Figure 10. Technicians must ensure that adequate supplies are maintained for operators according to Section 4.3.1.1.11.

4.3.1.2.4 Operator Liaison

Environmental technicians should visit event sites at least once a week to pick up precipitation samples collected by the operators and to check the instrumentation. During these visits the technician should discuss with the operator about any problems they might have encountered; ask about the status of supplies; inquire about any site peculiarities; and check over the samples and operator sample record sheets.

The operator should be kept informed of any developments in the program. The technician should convey to the operator all relevent progress of the study and any new development which could affect their monitoring site. An operator's newsletter is to be issued semi-annually from head office to inform operators of major developments and activities within the program.

It is very important to ensure that operators follow standard operating procedures. To achieve this, technicians should make sure the operator understands and can carry out the procedures required of him. Technicians should impress upon the operators that standard procedures must be followed in order to maintain the consistent collection of quality samples.

4.3.1.2.5 Sample Handling

Precipitation samples should be visually checked for cracks, flaws, or any visual signs of contamination (large particles, leaves, etc.). These observations should also be entered onto the operator sample record sheets. Operator sample record sheets are to be reviewed to ensure all field information has been properly entered. The samples are transported to the regional office in insulated coolers with ice packs and are immediately removed and placed into a refrigerator. Samples can now be processed and a field pH taken (only if the sample volume $\geq$ 85 mls. -Section 4.3.1.2.6)

Process the samples as follows:

1. Affix a field sample number to each event sample and affix its duplicate number to the corresponding field submission sheet. (Section 4.3.1.2.7)

2. Weigh the submitted sample bottles. Zero the scale and place the sample bottle onto the scale. Subtract the weight of an empty bottle (54 g). Since the density of water is 1.0 gram/ml, the number of net grams weighed equals the number of mls (submitted volume). Calculate the total volume of the event sample by adding the excess volume from the operator sample record sheet to the submitted volume which was calculated by weighing the event sample bottle. Report this value as the total volume on the field submission sheet (Section 4.3.1.2.7).

3 Take a field pH following Section 4.3.1.2.6 only if the submitted volume is greater than or equal to 85 mls. Record the field pH on the field submission sheet.

4. Transcribe the remainder of supporting field data from the operator sample record sheet to the field submission sheet. File the operator sample record sheet in your files.

5. Pack and ship the samples following Section 4.3.1.2.8.

4.3.1.2.6 Field pH Measurements

Event precipitation samples with volumes greater than or equal to 85 mls have a field pH measurement taken. The laboratory requires a minimum volume of 35 mls. for a total analysis of a sample. Therefore, using 50 mls for a field pH measurement brings the minimum volume to 85 mls. (35 + 50). The following procedures are to be followed for field pH measurements. Only a low conductivity, "Ingold" type electrode is to be used for precipitation samples.

1. All glass beakers are to be thoroughly washed and then rinsed with distilled deionized water.

2. Turn the pH meter on with the function switch in the standby position. Allow a few minutes to warm up the meter.

3. Check the electrode for crystals (KCl) and the level of the filling solution. Crystals must be present at all times, however, only a few crystals are required, as overloading will cause crystals to clump together resulting in a slow electrode response. (see Troubleshooting below)

4. Rinse a clean beaker using a small amount of the precipitation sample to be measured. Pour 40 ml from the sample bottle directly into the beaker. Allow the sample in the beaker to reach room temperature. All samples and buffers must be allowed to equilibrate at the same temperature before analysis. Set the temperature compensation control to the temperature of the buffers and samples to be analyzed.

5. Rinse the electrodes with deionized distilled water. Rinse a beaker and the electrodes with a sample portion of a pH 7.0 buffer solution. Discard the buffer from the beaker and refill with a fresh quantity. Lower the electrode into the sample and allow the meter to stabilize. Adjust the meter to read 7.00 by adjusting the buffer control knob. Wait about 1 minute or until a stable reading is acquired.

6. Follow step 5 above using a pH 4.00 buffer solution. Adjust the meter to read 4.00 by adjusting the sensitivity dial. The sensitivity control setting should always be in the range of 98-100%. If it drops below 98%, reactivate the electrode as indicated below in the Troubleshooting section.

7. Read the buffers (4.00 and 7.00) again and they should agree. Repeat steps 5 and 6 until they do. (Note: Always rinse the electrode with deionized distilled water between buffers and samples. Pat dry. Do not wipe as this may cause static build up.)

8. Repeat step 5 using the sample under test. Samples are read to the nearest 0.01 pH unit. (Note: A slow response time of a minute, or more implies that the electrode is deteriorating - see Troubleshooting.)

9. After all measurements have been completed, rinse the electrode thoroughly with deionized distilled water. Store the electrode in a beaker of deionized distilled water.

Troubleshooting:

Electrodes are always accompanied with a set of manufacturer's instructions and these should always be followed. If the electrode response becomes slow or unstable, the following procedures should be followed.

1. Electrodes stored in deionized distilled water will sometimes dehydrate the glass membrane. Soak the electrode in 0.1 M HCl for 2 hours. Follow this by soaking the electrode in a buffer solution (pH - 7.00) for approximately 1 hour. Thoroughly rinse with deionized distilled water and re-check the response characteristics.

2. Slow and unstable response may be due to the coating of the glass membrane. To correct this fault, wash the membrane with acetone and rinse thoroughly with deionized distilled water.

If neither of the above procedures remedy the response of the electrode, the electrode should be replaced.

4.3.1.2.7 Field Submission Sheets

A field submission sheet is filled out for every event precipitation sample submitted for analysis. The following descriptions outline the procedures to fill out these sheets (called Deposition Field Submission Sheet - Figure 11). Use only a black pen to fill out these sheets.

SAMPLING INFORMATION

Field Sample Number: Affix the duplicate number which is fastened to the sample bottle.

Collection Period: Enter the code "2".

Instrument: Enter the code "2".

Sample Type: Enter the code "1".

Station Number: Enter the station number. Note: For co-located instruments, one instrument is denoted as the secondary instrument and has a unique station number which is to be entered. Note: for blank bag (stock) submissions, use station number 3092 and write your region in the comments section.

Methodology: Enter "1".

Sampling Start: Enter the start date and time for the precipitation sample. The start time is considered the time when the bag was checked (or inserted) prior to precipitation occurring. Note: The following entries are to be used for quality assurance samples.

- Composites: The sampling start date is the handling date of the composite sample.
- Field Blanks: The sampling start date is the day and time the sample bag was inserted into the collector.
- Blank Bags: The sampling start date is the day the blank bag was sealed before shipping for analysis.

Bag In: The date and time the sample bag was inserted.

Sampling End: The samping end is the day and time the sample bag was removed from the collector. Note: Special cases for quality assurance samples are:

Composites: The sampling end is the day and time the operator handled the composite in the collector.

Field Blanks: The sampling end is the date and time the field blank was removed from the collector.

Blank Bags: The sampling end is the date and time the bag was sealed. Note that for blank bags the start and end dates and times are identical.

PRECIPITATION INFORMATION

Type of Sample Submitted: Enter in the appropriate code.

Precipitation Time: Enter in the start and finish times of the precipitation event.

Volume: Enter in the excess volume which the operator has recorded on the operator sheet. After weighing the sample enter in the submitted volume. Add the two values together and enter in the total volume of the sample. Note: The following are special cases.

Duplicate: Duplicate samples are submitted using separate field submission sheets. However, the total volume must take into account the other volumes which are submitted. Therefore, the designated regular sample's excess volume is to be the value obtained by adding the excess volume indicated by the operator (if any) and the submitted volumes of the duplicates. This excess volume added to the submitted volume of the regular sample will then represent the total volume of precipitation from the original sample.

Supplmentary Depth: If applicable.

Gauge Type: Enter in the appropriate code.

Measured Depth:	Applicable for cumulative sampling only (mm).
Temperature:	Applicable for cumulative sampling only.
Gauge Depth:	Enter the depth obtained by the precipitation gauge (mm).
Malfunction Details:	Enter in the inclusive dates of the sampler malfunction.
Field pH:	Enter the field pH to two decimal places.
Date Measured:	Enter the date the field pH was taken.
Field Comments:	Enter appropriate codes.
Sample Dilution	Applicable only for Toronto technician. The exact volume to one decimal place is to be filled out prior to a standard laboratory dilution of the sample to 40 mls using DDW.
Remarks:	Enter any remarks or comments which could have affected the sample. For quality assurance samples indicate what type of sample it is.
Station Name:	Enter the station name and type of sample.
Operator:	Enter the initials of the operator.
Submitted By:	Enter the technicians name.

4.3.1.2.8 Sample Shipment

Samples are shipped in coolers with their respective field submission sheets enclosed in a plastic bag. The samples are to be shipped as soon as possible after processing. However, never ship the samples on a Friday since shipping on this day would allow the samples to sit unrefrigerated over the weekend. The samples are to be shipped upright in insulated coolers with surrounding ice packs. The samples are shipped by courier to the attention of the sample coordinator at the MOE Laboratory on Resources Road in Toronto. Upon arrival, the coolers are immediately placed in a refrigerator located in the sample reception area of the laboratory.

4.3.1.2.9 Quality Control/Quality Assurance Procedures

To ensure that handling procedures are followed correctly and to obtain estimates of precision and accuracy, the following procedures are to be implemented as part of the quality assurance plan. Details of these procedures are contained in the quality assurance manual (1).

4.3.1.2.9.1 Procedures Audit

Every six months the environmental technician is to observe the operator's procedures for the collection of precipitation samples. Any deviations from standard procedures are to be pointed out at the end of the audit. After the discussion of the incorrect procedure the operator is then shown the correct procedure. Convey to the operator that the purpose of the audit is not to identify good or poor operators since some changes from the procedures may or may not contaminate a sample. The audit's purpose is to ensure the use of standardized procedures in the network.

4.3.1.2.9.2 Field Blanks

In the event precipitation network, new sample bags are inserted only after a sample has been collected. In order to ensure that sample bags are not collecting any form of dry deposition during dry periods, sample bags will be collected after dry periods and analyzed as a dry bag. Every operator is to collect one dry bag per month to be submitted as a dry bag. Technicians are to monitor these submissions to make sure field blanks are submitted on a regular basis from every site. Indicate on the summary sheets (Section 4.3.1.2.9.6) the submission of a field blank by coding under the appropriate collection day (ex: "3FB" 3 day field blank).

Operators should try to submit field blanks that have been exposed to as many "dry" days as possible. The longer exposure period is more susceptable to indicate any dry deposition. This requires the operator to listen to weather forecasts on the radio or television in order to decide whether to collect the blank or leave it for another day.

Operators are to follow normal operating procedures when collecting the bag. The bag is to be tied with a twist tie 1 inch below the point where the bag is folded over the outside edge of the bucket. The bag is to be sealed at the point where the bag was tied. The corresponding field sheet is to be coded as a field blank under the heading "type of sample submitted". All other field information is entered as a normal event precipitation sample. Technicians are also to code the sample as a field blank on the field submission sheets. The sample is to be coded as "dry" under the heading "Sample Type" and coded as "field blank" under the heading " Type of Sample Submitted". Upon reception at the laboratory, the field blank is then analysed as a dry bag.

4.3.1.2.9.3 Composite Samples

Composite samples prepared by the laboratory will be handled by the operator and processed following standard operating procedures. This procedure will be carried out semi-annually at every event site. A polyethylene bottle containing a composite solution will be distributed to every operator. Technicians are to weigh these samples prior to distributing them to the operators. Record the volume on the field sheet under "comments" by writing "Initial Volume = ". The operator is to insert a new sample bag into the collector and carefully pour the composite into the sample bag. The sample is immediately removed and processed as a regular event sample. This procedure can be carried out when the technician visits the site to deliver the composite or the composite sample can be picked up by the technician the following week.

Technicians are to submit these composites following regular procedures and code the samples on the field submission sheets as composites under the heading "Type Of Sample Submitted". The sample co-ordinator at the laboratory in Toronto will receive these composite samples and submit them under a separate submission number. All these samples will be analysed in the same laboratory run.

4.3.1.2.9.4 Duplicate Samples

Duplicate samples will be submitted by the operator whenever there is enough excess volume to fill an additional sample bottle. Standard operating procedures require an event sample to be decanted into a 450 ml polystyrene bottle with any excess volume measured in a graduated cylinder. For the submission of duplicates, the excess volume (prior to measuring in the graduated cylinder) is to be used to completely fill one sample bottle (any excess volume is again measured). The duplicate sample received from the operator is to be split into two samples by the technician and labelled and submitted as duplicate samples. Code these samples as duplicates on the field submission sheets. The sample co-ordinator will then submit the duplicate samples blind to the laboratory for analysis.

4.3.1.2.9.5 Co-located Sampling

Technicians are to set up co-located instrumentation at one event site in every region. An additional precipitation collector, standard rain gauge and nipher shielded snow gauge will provide estimates of precision for the instruments used in the event precipitation network.

The co-located precipitation samples collected from these sites will be submitted as regular samples. Each instrument will have its own unique station identifier which is coded on the field submission sheet.

4.3.1.2.9.6 Summary Sheets

To monitor the collection of samples between event sites (ie: sites 10 km apart, 100 km apart) and to verify consistent sampling, technicians are to fill out a summary sheet (Figure 12) of the volumes, gauge depths, and types of samples collected from each site. The following is a description of the codes to be used for filling out these sheets. Completed sheets are to be sent to the Technical Co-ordinator at the beginning of every month. Note that all entries and codes are entered into the corresponding day which represented the day of precipitation. For example, a sample which was removed on the morning of September 4th would be coded into the September 3rd location. Composites, however, are coded into the day they were inserted and removed.

Volume - enter the volume collected (ml) for each site on a daily basis in the appropriate box.

Gauge Depth - enter the gauge depth (mm) for the precipitation event.

Special Cases:

1. If there is no volume collected in the sample bag but a gauge measurement is taken, then enter "O" for volume and then enter the gauge depth.

2. A multiple day sample is identified by parentheses.

3. For days of no precipitation in either the bag or gauge enter a slash, "-".

4. A spilled sample is coded as an "S"; a trace sample is coded as a "T"; and a malfunction is coded as an "M".

5. Field blanks are coded as "FB" with the number of exposed days proceding the letters, ex: "3FB" - 3 day field blank.

7. Duplicate samples submitted are coded as a "D", and composite samples are coded as a "C".

4.3.1.2.10 Winter Changeover Procedures

Precipitation gauges are changed at the end of October to prepare for winter sampling methods which commence November 1 (October 1 for NW Region). The standard rain gauge is replaced by a nipher-shielded snow gauge. These changes should be completed on or before November 1 of every year. Similarly, modifications are carried out prior to May 1 to revert back to summer sampling methods.

4.3.2 Event Air Sampling Network

The event air sampling network's objectives are to determine the amount and origin of airborne acid-related pollutants and to estimate dry deposition rates of these pollutants on a daily basis. This network is comprised of 4 monitoring sites, namely Longwoods Conservation Area, Dorset, Charleston Lake Provincial Park, and Ely, Minnesota (known as the Fernberg site). Located at each site is an air filtration system for the measurement of ambient concentrations of sulphur and nitrogen compounds.

The technicians responsibilities are to operate and maintain the sampling instrumentation and to load and unload the filter packs. The following procedures describe in detail these responsibilities.

4.3.2.1 Environmental Technician Procedures

The following procedures are to be used to collect and submit samples in the event air sampling network.

4.3.2.1.1 Filter Preparation and Storage

The teflon and nylon filters used in the sampling network are obtained commercially from Membrana Corporation (effective 1987, Gelman). The cellulose (Whatman-41) filters are impregnated with a potassium carbonate/glycerol solution at the headquarters in Toronto. All Whatman-41 filters are stored in a desiccator and the nylon/teflon are stored in their original containers prior to deployment in the field.

Solution Preparation:

1. Wash the roller, tray, volumetric flask, and glass sheets thoroughly using ethanol and rinsing with deionized distilled water. Dry this equipment using Kimwipes.

2. Add into a 1 litre volumetric flask approximately 300 mls of deionized distilled water. Dissolve 250 g of potassium carbonate (K_2CO_3) into the deionized distilled water.

3. Add 100 ml of glycerol to this solution. Bring the total volume of the solution up to 1000 ml with deionized distilled water.

4. Thoroughly mix the 1 litre solution to dissolve the K_2CO_3 completely.

Filter Impregnation:

1. Pour a sufficient amount of the solution into the clean tray to cover a filter sheet. Using clean polyethylene gloves and clean forceps soak the 8" x 10" Whatman 41 filter sheets in the solution (soak individually).

2. Place the soaked filter sheets onto the clean glass sheets. Any excessive solution is then removed by using a hand held roller.

3. Place the sheets into a drying oven for approximately 30 minutes at 60°C.

Filter Cutting:

1. After the filter sheets have been dried, place a non-impregnated sheet on the top and bottom of a stack of five impregnated sheets. These sheets are then placed on a plastic cutting board.

2. A 50 mm cutting die cleaned with ethanol and deionized distilled water is placed onto the drill chuck. The sheets are cut, discarding the top and bottom non-impregnated cut filters. The impregnated cut filters are then placed into new Whirlpak bags. Each bag is given a batch number prior to shipment to the field technicians.

The impregnating and cutting of filters is to be carried out every 3 months. Technicians are given a 3 month's supply of all filter types to be used in the networks (both event and cumulative network). Filters are stored in desiccators in the regional offices to avoid any contamination. All filters have associated batch numbers which must be recorded on the outside of the filter storage containers or bags.

4.3.2.1.2 Loading of Filter Packs

Filter packs are to be washed after every sampling period. The following washing procedures are to be followed prior to loading the packs:

1. Disassemble all filter packs and place the parts and 2 pairs of teflon-coated tweezers in a sink full of warm water and laboratory detergent.

2. Put on a clean pair of disposable polyethylene gloves and scrub all parts with a soft brush. All gaskets and filter screens need to be thoroughly cleaned.

3. Using clean gloves thoroughly rinse the parts with tap water. Follow with two rinses of deionized distilled water.

4. Set aside the filter pack parts to dry on a clean tray. To speed up drying, the parts can be placed in a drying oven at 60°C for 30 minutes. If left to air-dry, the washed parts should be covered with Kimwipes to prevent possible contamination.

5. When dry, the filter packs are to be stored in clean bags (Zip-loc or Whirlpak) or used immediately to load filters.

The filter handling area in the field office should be a clean work area. Smoking nearby is not allowed while handling filters. The following procedures are to be followed for loading filter packs. Each sampling period requires eight loaded filter packs. Seven packs are active and one of the packs is to be used for passive sampling.

1. Pour 50 ml of ethanol into a clean 250 ml beaker. Insert a clean pair of teflon tweezers into the beaker.

2. Layout clean Kimwipes over the filter loading area and disassemble the filter packs placing the top collar and each stage upside down over the Kimwipes.

3. Open the Whirlpak bag containing the W-41 filters and remove the protective covers from the boxes containing the nylon and teflon fitlers. (Teflon container might be marked Zefluor.)

4. Wipe the tweezers dry with a Kimwipe.

5. Place a teflon filter into the top collar of all the packs. Since the top collar and stages are placed upside down, the filters must be placed into the filter pack upside down. This requires the teflon filters to be placed into the top collars dull side up. (The smooth shiny side is the collection surface.)

6. Rinse the tweezers in the ethanol beaker and wipe dry with Kimwipes. Place a nylon filter upside down into the top collar over every teflon filter.

7. Insert the first stage of the pack into the top collar containing the filters. Visually check to ensure the top O-ring has not failed or shifted.

8. Rinse the tweezers in the ethanol beaker and wipe dry with Kimwipes.

9. Remove two impregnated W-41 filters from the bag and place them into the bottom of the first stage of every pack. Ensure these filters are properly seated inside the O-rings by gently tapping the edges of the filter.

10. Carefully insert the second stage downward into the first stage to complete the loading of the pack.

11. Place numbered stickers on the side of every pack to identify which sampling ports the packs will be fastened to. Enclose each pack into its own Whirlpak bag. (Note: one pack will be labelled "passive" and one numbered 1/8 while the other 6 active packs will be numbered 2 to 7.)

12. Place all the packs into a new Zip-loc bag along with 8 new Whirlpak bags. The new bags will be used for removing and storing the exposed packs.

NOTE: During steps 5-7, ensure that the filter dividers are removed from the teflon and nylon filters.

4.3.2.1.3 Deployment of Filter Packs

Filter packs are replaced on the tower every Tuesday. All packs sequence at 0800 hours **local time** (except Fernberg which is changed 0700 hrs local). The following procedures are to be followed for deploying new packs.

1. Record the sampling flow rate on the rotameter as the "end" flow on the field submission sheet.

2. Turn the instrument off. Record the total volumes for every sampling port.

3. Lower the sampling boom. To remove a filter pack, fit a new Whirl-pak bag over an exposed pack and screw the pack counterclockwise off the baseplate. Twist tie the Whirlpak bags forcing out any excess air.

4. Remove all exposed packs except the pack on port #8. The filter pack on port #8 is the pack which begins sampling every Tuesday. This pack must be moved to port #1 to complete the 24 hour sampling period. The total volume for this pack labelled "1/8" must be calculated by adding the volumes recorded on counter 1 and the previous week's volume on counter 8. As well, this pack will have 2 passive pack corrections since it remains on the sampling boom for 2 weeks.

5. The new filter packs can now be installed on port numbers 2 to 8 as well as installing the passive filter pack.

6. The boom can be raised and locked in place.

7. All channels are now zeroed and the sample is cycled to channel number 1. Check the instruments following Section 4.3.2.1.6 "Instrument Checks".

NOTE: It is very important to label the packs so that no confusion exists when loading and unloading packs on the tower. The baseplates on the sampling boom are to be labelled to prevent any errors during the deployment of new packs.

4.3.2.1.4 Unloading of Filter Packs

The following procedures are to be used for unloading filter packs.

1.. Pour 50 ml of ethanol into two clean 250 ml beakers. Place a pair of clean teflon coated tweezers into each beaker. One beaker and a pair of tweezers are used for handling impregnated filters only. The second beaker and pair of tweezers are to be used for handling the teflon and nylon filters. Lay clean Kimwipes over the filter unloading areas.

2. For each filter pack, three Whirlpak bags should be labelled Teflon, Nylon, and W-41.

3. Using disposable plastic gloves and tweezers, carefully remove the top collar and pick up the teflon filter by the edge, being careful not to touch the darkened exposed area.

4. Using tweezers fold the exposed filter onto itself into quarters and place it into the corresponding Whirlpak bag forcing out any excess air before closing.

5. Repeat Step 4 to unload the nylon filter.

6. Remove the second stage from the first stage of the filter pack.

7. Using the ethanol solution reserved for impregnated filters, remove the tweezers and pick up the two W-41 filters by the edge and fold into quarters. Place the folded W-41 filters into the corresponding Whirlpak bag forcing out any excess air before closing.

8. Enclose the three Whirlpak bags containing the exposed filters into another Whirlpak bag labelled with the corresponding station name, station number, and sampling period. Affix a field sample number to the bag and affix the duplicate field sample number to the field submission sheet.

4.3.2.1.5 Field Submission Sheets

A field submission sheet must be filled out for every filter pack submitted for chemical analysis. The following outline is to be followed to fill out the air sampling field submission sheet (entitled "Air Sampling Field Data", Figure 13). Use only a black pen only to fill out these sheets.

Field Sample Number: Affix the duplicate number which is fastened to the Whirlpak bag containing the filters.

Collection Period: Enter the code "02" for all the filter packs (including the passive filter pack).

Instrument: Enter the code "21"

Sample Type: Enter the code "21"

Station Number: Enter the station number. For co-located sites a secondary station number is used. The designated station number is 3092 for filter blanks submitted by headquarters.

Methodology: Enter the code "01"

Sampling Start: Enter the date and time the filter pack started (the sequencing or start time should be 0800 hrs local time - except Fernberg which is 0700 hrs local)

Sampling End: Enter the sampling end date and time

Special cases: For handling blanks the sampling start is the date and time the pack was loaded while the sampling end is the date and time the pack was unloaded. Batch blanks start and end dates are the dates the blanks are submitted.

Sampling Port Number: Enter the port number the filter pack sampled on. For the 1/8 filter pack enter "18".

Filter Use: Enter the use of the filter. If an active filter pack malfunctions and no volume is sampled still enter in "1". Only the designated passive filter pack is coded "2". Note that quality assurance handling blanks are coded "3" and batch blanks are submitted under "4".

Volume Sampled: Enter the volume (litres) which is read from the sampler counters. For the "1/8" pack this volume is a total of two counters. For handling and batch blanks, enter "0" for the corrected volume.

Volume Correction: This correction is the percentage error of the volume counters determined by the last calibration. Enter above the "corrected volume" this percentage (to the nearest unit) and include whether it is a negative or positive percentage. (i.e. +5% means the volume counters are reading 5% high, therefore the actual volume is 5% less the counter volume)

Note: Use the appropriate correction factor, ie.:

$$\text{if } \left[\frac{\text{True Vol. - Observed}}{\text{True Vol.}}\right] \text{ is used then } \Longrightarrow \div$$

$$\text{if } \left[\frac{\text{Observed - True Vol.}}{\text{Observed}}\right] \text{ is used then } \Longrightarrow \times$$

Corrected Volume: Enter in the corrected volume in litres using the volume sampled and volume correction factor.

Rotameter Reading: Enter the "start" and "end" flowrates in litres per minute.

Elapsed Sampling Time: Enter the elapsed time (applicable for low volume sampling only).

Filters Submitted: Enter a "1" in the boxes which indicate the filter types submitted. eg: for event air sampling, the Teflon, Nylon, and W-41 boxes would have a "1" entered.

Associated Passive Numbers: Enter the passive filter pack field sample numbers that the exposed pack is associated with. Note that only the pack marked "1/8" will have two passive numbers entered here.

Associated Batch Numbers: Enter the batch numbers for each filter submitted. The batch number is the number recorded on the outside of the filter storage container or bag.

Field Comments: Enter the appropriate codes if applicable. Enter codes starting from the left side.

Special Remarks: Enter any comments or observations which might have affected the filter during the exposed period. If a quality control or special study sample is submitted, write down the type and purpose of the sample.

Station Name: Enter the station name (eg: Longwoods)

Operator's Name: if applicable (other than technician)

Submitted By: Technicians name is entered here

These submission sheets are to be shipped with the unloaded filters to the sample co-ordinator at the laboratory. Event air sampling filters and cumulative air sampling filters are to be shipped individually to avoid mixups. If air filter shipments are shipped with precipitation samples in a cooler, enclose the filters and field submission sheets in a sealed plastic bag.

4.3.2.1.6 Instrument Checks and Log Books

During the deployment of filter packs, various checks and observations of the air sampler are to be made.

1. Check the timer. The timer should be on the correct time.

2. The flowrate should indicate the flow calculated by the last calibration to correspond to 20 lpm.

3. The pump should not be excessively hot or noisy.

4. The sampler should be manually sequenced to ensure all ports are sequencing normally.

Instrument log books (Figures 6-9) are to be maintained in the same manner as section 4.3.1.2.2 entitled "Log Books". All calibration sheets are to remain in the log book with a copy sent to the Technical Co-ordinator and a copy kept on file by the technician.

4.3.2.1.7 Quality Control/Quality Assurance Procedures

The following procedures are to be carried out to ensure the quality of data collected from the event air sampling network.

4.3.2.1.7.1 Procedures Audit

A procedures audit will be carried out annually at every event air sampling site in the network. This audit will consist of observing the techniques used for filter preparation, loading and unloading of filters, storage of filters, deployment of filters, and audit calibrations of the sampling equipment. Details of these audits are contained in the quality assurance manual (1).

4.3.2.1.7.2. Blank Filters and Handling Blanks

To ensure the quality of filters used in the air sampling network, filters are submitted to the laboratory for blank analysis. For all teflon and nylon filters purchased commercially, 5 filters of each type from every lot number are submitted for analysis. For every Whatman-41 filter batch, 5 filters are submitted for blank analysis. Action is only taken to remove filters from the sampling network when the detection limits of the chemical parameters are exceeded.

Environmental technicians will also load a filter pack in the regional office and then ship the pack sealed in a Whirlpak bag to a monitoring site to be stored unexposed for a representative time period (28 days, low-vol; 1 week-daily). This procedure will be carried out quarterly. Technicians are to code these blank packs as "Handling Blanks" under the heading "Filter Use" on the field submission sheet.

4.3.2.1.7.3 Co-located Sampling

One co-located daily air sampler is to be installed at Dorset to determine the precision of this air sampling methodology. The filters for this site are to be coded as co-located site samples using the 3012 station number on the field submission sheets.

4.4 Cumulative Network

The cumulative network consists of a precipitation and an air sampling network. The following sections document the standard operating procedures in both types of networks.

4.4.1 Cumulative Precipitation Network

4.4.1.1 Operator Handling Procedures

The responsibility of the operator is to collect a precipitation sample after a 28 day period, and to check the instrumentation once per week. The collection of these samples involves removing a sample bag from the collector and inserting a new bag for the next sampling period. At selected sites where air sampling equipment is installed, a filter pack must be removed and a new filter pack installed at the end of the sampling period. The operator is required to fill out an operator sample record sheet to accompany each sample to the laboratory. An operator log book must also be maintained to provide supportive information for data validation and analysis.

Generally, depending on the location of the cumulative site, an environmental technician will visit the site every month to collect the samples and check the instrumentation to verify that it is operating properly.

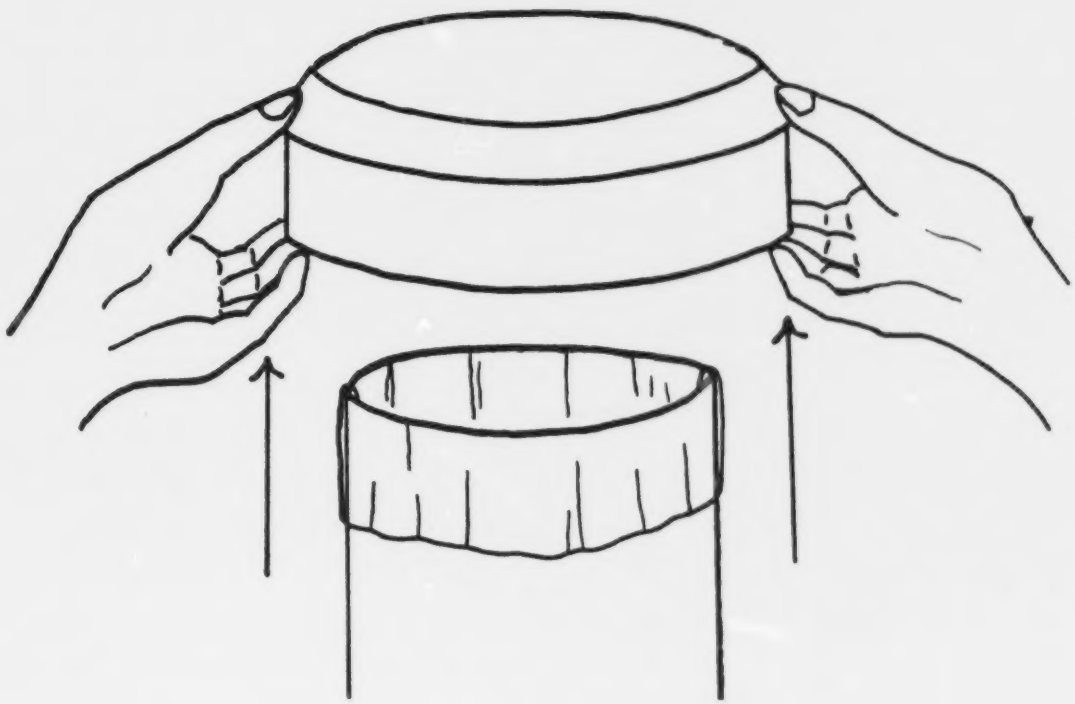
The network has initiated a comprehensive quality control/quality assurance program to collect high quality samples. Operating procedures are thoroughly described in the following pages. It is recommended that every operator review them regularly to assure that proper procedures are followed at all times. Precipitation samples can be easily contaminated. To maintain a high quality network, procedures must be strictly adhered to.

The following operating procedures are to be followed for collecting cumulative precipitation samples.

4.4.1.1.1 Removal of the Collected Sample

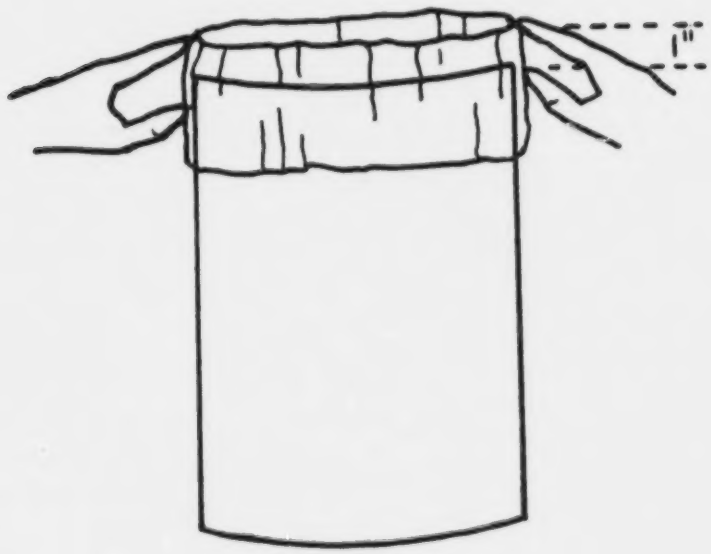
1. Touch the sensor grid with a wet finger to activate the hood. When the hood has moved to the dry side, turn off the instrument.

2. Prior to removing the collar and bag, it is crucial that the operator's hands are dry and clean. To remove the sample bag, the collar around the wet bucket must be removed first. This is done by grasping the bottom and side edge of the collar and then lifting off gently. Place the collar down on top of the support stand. Do not touch the inside of the collar or make any contact with the inside surface of the sample bag.

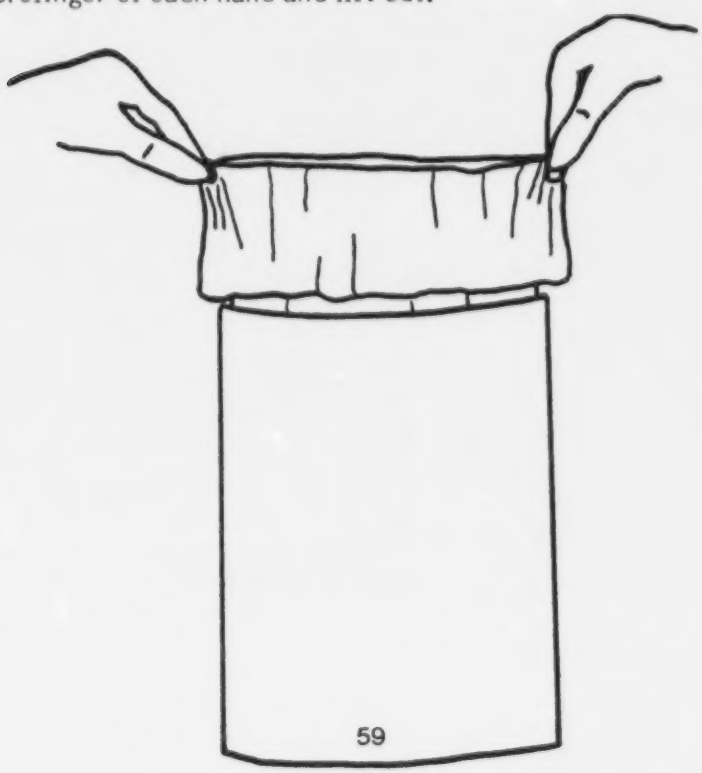


3. Remove the sample bag as follows:

(i) Gently push the portion of the bag which is outside the bucket up over the top of the bucket for about 1 inch.

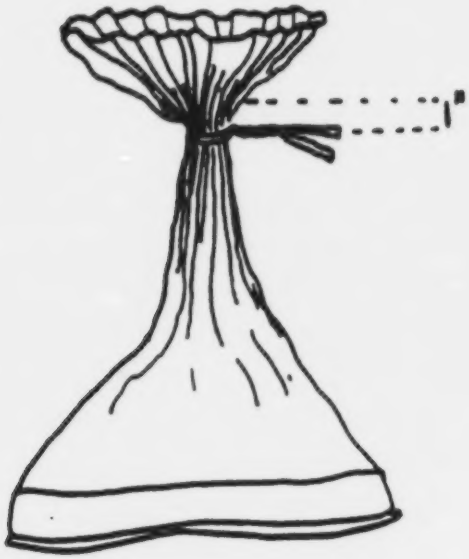


(ii) Squeeze the portion of the bag above the bucket between the thumb and forefinger of each hand and lift out.



(iii) Holding the two sides together at the top of the bag with one hand, move the other hand down and grasp the bag just under the fold, approximately one inch down from the point where the bag folded over the edge of the bucket.

(iv) Gently squeeze out any excess air in the bag and then tie the bag at the point where the bag was squeezed in step 3(iii) with the twist tie provided. Place the sample upright into the supplies box.



4.4.1.1.2 Instrument Cleaning

1. Clean the polyethylene/foam gasket on the underside of the hood as follows:

   (i) Wet a Kimwipe with ethanol.

   (ii) First, clean the area of the gasket that was outside the bucket when the hood was covering the bucket. This is cleaned first because the outside area tends to accumulate dirt which could contaminate the sample while the portion inside should be cleaner.

   (iii) Repeat the cleaning with another ethanol-wetted Kimwipe to clean the entire gasket.

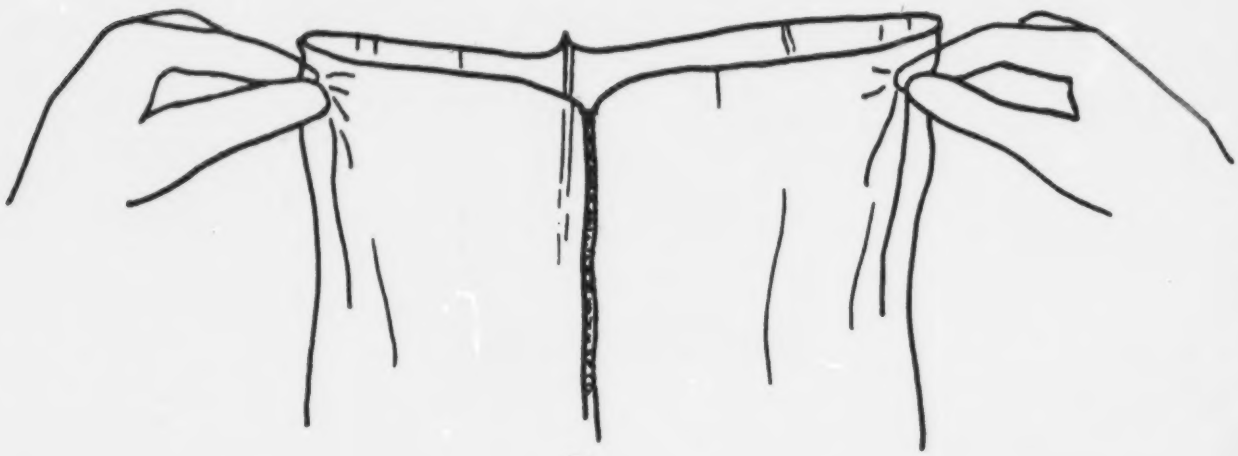
   (iv) Wet a Kimwipe with deionized distilled water and clean the entire gasket. Wipe dry with a Kimwipe.

2. Clean the sensor grids with a Kimwipe wetted with ethanol.

4.4.1.1.3 Deployment of a New Sample Bag

Only after cleaning the gasket and sensor grids should a new sample bag be inserted.

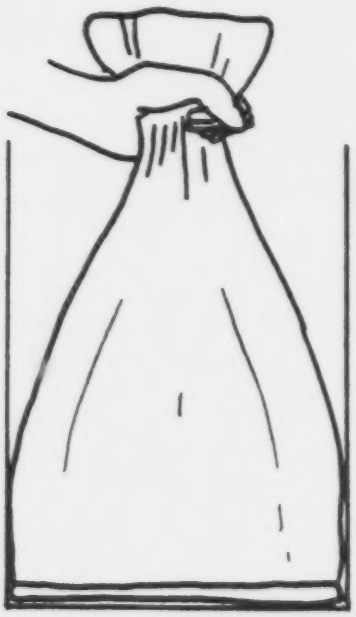
1. Put on a clean pair of disposable plastic gloves. Grasp a new bag near the top and separate the two halves.



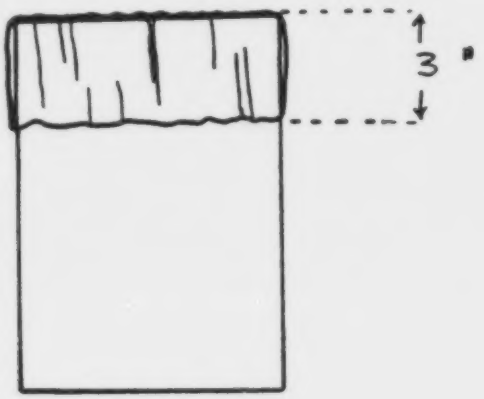
2. Shake the bag in the air until it has separated and expanded fully.

3. Leave a small amount of air in the bag and squeeze near the top so that the bag is half full of air.

4. Push the bag into the bucket until it hits the bottom.

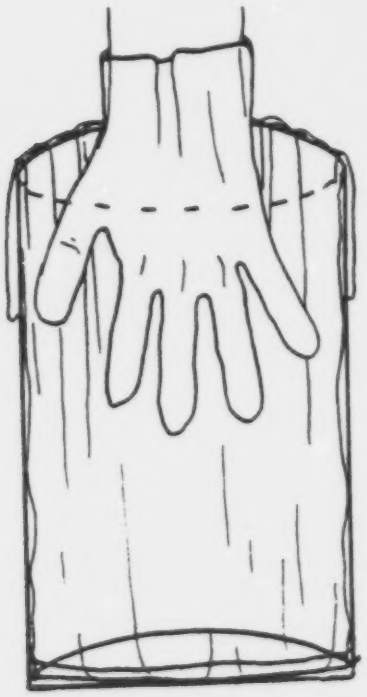


5. Slide the top of the bag over the top of the bucket so that 3 inches of the bag extend down the outside of the bucket.



6. Put on a clean glove being careful not to touch the fingers of the glove. (Note: It is very important to use a new glove because the next step requires the hand to touch the inside of the bag.)

7. Reach into the bag at the rim of the bucket and flatten the bag against the walls of the bucket. Do not shove your hand all the way into the bag. Only put your hand in as far as the length of the plastic gloves.



8. Clean the collar with a Kimwipe wetted with ethanol by starting on the inner surface and working outward. Repeat the cleaning using a Kimwipe wetted with distilled deionized water. Dry with a Kimwipe.

9. Place the collar over the top of the bucket being careful not to touch the inside rim.

10. Turn the instrument back on. The hood should return and cover the wet side bucket. Follow procedures under Section 4.4.1.1.4 "Instrument Checks" to verify the instrument is working properly.

4.4.1.1.4 Instrument Checks

The following is a short list of instrumentation checks which is to be carried out once every week and after deploying new sample bags. If any of the checks below indicates a problem, contact the technician as soon as possible. (Section 4.3.1.1.13, "Contact Information")

- Ensure that the wet bucket is sealed completely by the hood. No gap should exist between the bucket and hood.

- Touch a sensor grid with a wet finger. The instrument should activate and move to the dry side.

- Touch both sensor grids to check that they are warm. They should not be too hot or too cold to the touch.

- Ensure that the hood returns and covers the wet bucket. The elapsed time between the initial activation and the return of the hood should be approximately 2 minutes ($\pm$ 30 seconds).

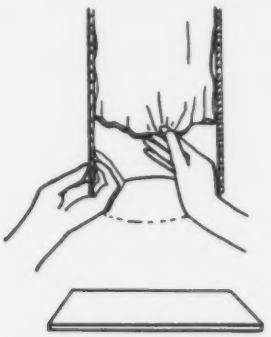
4.4.1.1.5 Winter Sampling Procedures

During the winter sampling period, November to April, a solution of methanol and ethylene glycol is added to the nipher gauge to prevent the precipitation collected from freezing. A thermometer is suspended into the gauge solution to record the temperature for every gauge measurement. This temperature reading is required to correct for the volume and density changes due to varying temperatures of the solution. All cleaning procedures using distilled deionized water are discontinued during the winter sampling period since water would freeze on contact leaving a thin film of ice.

For the first sample changeover in November, remove the inner support platform and install a long sampling bag. These longer bags are to be used during the winter sampling period.

1. Removal of Collected Sample

The procedures are the same for summer sampling except when the bag is lifted out during step 3(ii), Section 4.4.1.1.1. In the winter the bag may get caught or jammed in the bottom of the tube. During step 3(ii), if this jamming occurs, lift the tube up from the bottom support platform and gently release the bag. Lower the tube back to its original position and proceed from step 3 (ii).



If there is a build-up of snow on the inside edge of the collar prior to removing the collar, tap the collar on the side forcing the snow to fall into the bag. Proceed to remove the collar and collected sample using the same procedures.

2. Deployment of a New Sample Bag

Follow the same procedures in Section 4.4.1.1.3

Note: During the changeover to summer sampling (April), the environmental technician will insert the inner support platform to support the shorter sampling bags used in the summer. Therefore, for the last changeover date in April, insert a small sampling bag into the bucket.

4.4.1.1.6 Nipher Gauge Measurements

The nipher shielded snow gauge provides a measurement of the total amount of precipitation occurring over a 28 day period. To determine this amount, the gauge depth must be measured using a metre stick at the end of every collection period. It is crucial that accurate measurements are taken. During the winter sampling period, a temperature reading of the storage gauge solution must also be taken.

1. Carefully place the metre stick into the center of the gauge. Make sure that the stick touches the bottom of the gauge and that it is perpendicular to the bottom of the gauge. Remove the stick and record the depth to the nearest decimal point (e.g. 43.2). Allow any solution on the metre stick to drip back into the gauge. Wipe the stick dry and store it away until the next changeover. Do not leave the metre stick in the gauge solution.

2. During the winter sampling period, the temperature of the solution is to be taken along with the depth measurement. Simply lift out the thermometer and record the temperature to the nearest degree (e.g. + 2^{o} C). Be careful handling the thermometer to prevent it from breaking.

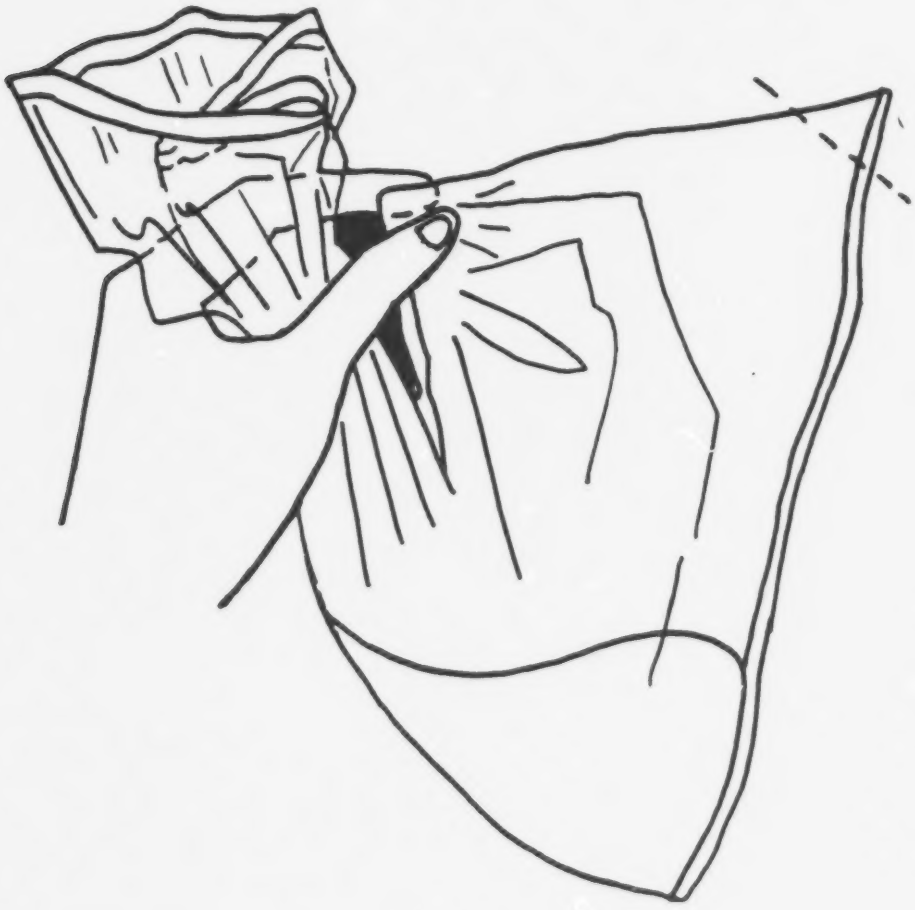
Note: If the gauge is not level, notify the technician when he visits the site. Also, if for any reason it is suspected that the depth measurement is not representative, i.e. someone tampering with the gauge during the month, debris fallen into gauge, leaking gauge, etc., notify the technician and record this information in the log book and on the sample record sheet submitted with the samples.

4.4.1.1.7 Leaking Samples

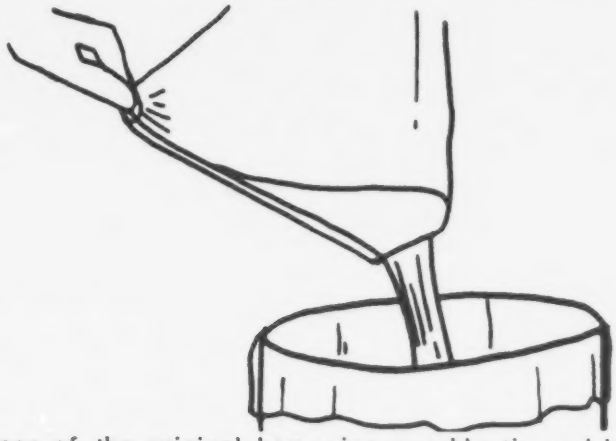
After the samples have been removed from the buckets the bags may develop leaks. If a sample is leaking, do not double bag the sample. Instead, follow the procedures outlined below. An extra bucket and pair of razor snips will be supplied for these procedures.

1. Open a clean new bag following section 4.4.1.1.3 "Deployment of New Sample Bags", and insert the bag into the supplied bucket following the same procedures.

2. Rinse the corner of the leaking sample bag with distilled de-ionized water and wipe dry with a Kimwipe. Rinse the razor snips with distilled deionized water and wipe dry with a Kimwipe. Holding the leaking sample as in the diagram below, carefully cut off a bottom corner of the bag.



3. Lower the corner of the bag and carefully pour the sample into the new sample bag.



4. Tie the cut corner of the original bag using a cable tie and label the bag "original" along with the station name, number, and collection date.

5. Remove the new sample bag from the bucket following section 4.4.1.1.1 "Removal of Collected Samples", and tie it using the same procedures. Label this bag the "transfer" bag along with the station name, number and collection date.

4.4.1.1.8 Operator Log Book

A log book is to be maintained on-site by the operator to provide a written record of samples collected, measurements, checks, and other pertinent observations. The log book will be occasionally reviewed by the technician responsible for the site. The following log book format should be followed.

Date	Time	Operation Check	Sample Field Data or Comments	(if applicable) Lo-vol Data or Comments
June 21/83	0930	OK	Sample removed, new bag inserted Gauge Depth 21.4 cm	End Flow 1.9 lpm Volume: 8084 Time: 670.82 New pack installed Start Flow 2.0 lpm
June 29/83	1130	OK	Lo-vol flow OK - 2.0 lpm	
July 6/83	1530	OK	Lo-vol flow 2.0 lpm	
July 7/83	0830	OK	Raining, instrument open	
July 14/83	1030	OK	Lo-vol flow adjusted from 1.8 to 2.0 lpm	
July 19/83	0900	OK	Sample removed, new bag inserted, poured in composite sample and removed. Inserted new bag 0915. Gauge Depth 33.6 cm	End FLow 2.0 lpm Volume: 7989 Time: 665.78 New pack installed Start Flow 2.0 lpm

Observations which might affect the sample are very important and should be entered under a section entitled "Observations" in the log book. During the data validation procedure, it is sometimes necessary to determine if anything unusual could have occurred to help explain a particular analysis result. Since the log book is the only written record of on-site peculiarities, it should be regularly maintained. Examples of observations might be: grass burned July 3 and 4, 1982; Hydro failure August 4, 1982 and precipitation missed during that day; heavy snowmobile traffic around sampler, etc.

4.4.1.1.9 Operator Sample Record Sheets

Each sample submitted from a cumulative site is to be accompanied by an operator sample record sheet (Figure 14) containing all relevant sampling information. The following is a description of how to fill out these record sheets.

Station Name: Enter the station name

Sample Collected By: Enter the operator's name.

Type of Instruments: Check off the appropriate instrument.

Type of Samples Collected: Check off the types of samples submitted. Note that co-located samples must have separate operator record sheets filled out.
For the wet sample bag, indicate the type of precipitation that fell during the 28 day period.

Sampling Start: Enter the date and time the sample bag was inserted into the bucket. Indicate whether it was precipitating during the insertion.

Sampling End: Enter the date and time the sample bag was removed from the bucket. Indicate whether it was precipitating during the removal.

Composite Handling Date: If the composite handling date is different from the sampling end date, enter the date and time the composite was handled.

Precipitation Gauge Measurements: Enter the observed depth and solution temperature (if applicable) of the gauge.

Lo-Vol Sampler Measurements: If a low volume air sample is submitted see Section 4.4.2.1.3.

Factors Affecting the Samples Collected: Check as many factors as necessary . Any other factors which could have affected the sample should be entered.

Instrumentation Problems: If a malfunction had occurred, enter the date the malfunction occurred (if known) and the date the malfunction was corrected. Describe the malfunction and indicate if any precipitation events were missed during the malfunction period.

Supplies: Check off as required. Do not wait until you are short of any supplies before contacting the technician. As soon as supplies are low, request more.

4.4.1.1.10 Procedural Short List

Removal of Collected Sample:

1. Activate the sampler and turn the instrument off when the hood has moved to the opposite side.

2. Remove the collar touching only the bottom and side edge of the collar.

3. Remove the sample bag being careful not to turn in the portion of bag exposed outside of the bucket.

4. Grasp the bag one inch below the fold, twist, tie, and store.

Instrument Cleaning:

1. Clean the gasket under the hood with ethanol and then distilled de-ionized water. Dry with a new Kimwipe.

2. Clean the sensor grids with ethanol. Dry with a Kimwipe.

Deployment of New Sample Bags:

1. Insert a new bag in the wet bucket following the detailed procedures. Flatten the bag against the walls of the bucket using a clean glove. Do not stick your hand all the way down into the bucket.

2. Clean the collar with ethanol and distilled deionized water starting on the inner surface and wipe dry with a new Kimwipe. Place the collar on the wet bucket being careful not to touch the inside rim.

3. Turn the instrument back on. Carry out the instrument checks.

Precipitation Gauge Measurement

1. Record the depth of the gauge solution and record the solution temperature if winter procedures are followed.

Log Book and Operator Record Sheets

1. Fill out the log book and operator record sheet including all pertinent information.

4.4.1.1.11 Supplies

1. Every operator should have at all times a 2-month supply of the following supplies.

   - sample bags
   - disposable gloves
   - kimwipes
   - ethanol
   - distilled deionized water
   - sample record forms
   - labels
   - cable ties
   - shipping boxes (if applicable)
   - packing tape (if applicable)

2. An operator should also have:

   - site log book
   - metre stick
   - technician's name and phone number
   - manual of operating procedures
   - extra bucket and scissors for transferring leaky samples

If an operator has less than a 2 month supply of any item above, contact the technician as soon as possible and inform him of the shortage.

4.4.1.1.12 Quality Control/Quality Assurance Procedures

To verify that samples are collected and transported following procedures, and to ensure that these procedures fulfill our quality control objectives, specific quality control checks and quality assurance procedures are to be implemented on a regular basis.

4.4.1.1.12.1 Procedures Audit

Annually, the field technician will ask every operator to go through their procedures to verify that the recommended procedures used by the operator are up to date and properly followed. The technician will observe the removal and insertion of sampling bags as well as the measurement of the storage gauge depth.

After these reviews, the technician will go through all the operating procedures with the operator so that all operators in the network will be using standard operating procedures at all times.

4.4.1.1.12.2 Composite Samples

To assess whether the measurement system is operating properly, samples of known concentrations will be introduced into the system and submitted to the laboratory following standard operating procedures. These samples will be composite samples prepared by the laboratory. A composite sample is a sample of precipitation which has been prepared by adding together excess volumes of precipitation samples previously collected. The operator will be asked to handle the composite and then follow the regular procedures of recording, labelling, and storing. The technician will pick up the sample and process it as he would any other sample. Any change in concentrations after the chain of handling steps should indicate sample degradation and/or potential contamination.

Composites will be contained in a 1 litre polyethylene bottle. Store the composite where the normal sample is kept until the technician picks it up. During the next changeover after new bags have been inserted into the collector, carefully pour the contents from the composite bottle into the wet bag. Immediately remove the wet bag and twist tie following the same procedures used for regular samples. Insert a new sample bag into the bucket for the regular sample. Process the sample labelling the bag "composite" and fill out an operator record sheet entering the coding "composite" under the heading "Type of Samples Collected". The technician will pick up the composite sample and the regular samples during his next visit to the site. This procedure will be carried out semi-annually at every site in the program.

4.4.1.1.12.3 Co-located Sampling

At one cumulative site in every region, a co-located sampler and a precipitation gauge will be installed. These samplers and gauges will provide estimates of precision for the measurement system of the cumulative network.

Co-located sampling is simply installing another precipitation collector beside the existing collector (of the same make and model), and then collecting two samples for every 28 day period. Similarly, two gauges are set-up and operated to compare precipitation depth measurements. Write on the co-located sample bag "co-located" and check off the box on the operator record sheet which corresponds to a co-located sample.

4.4.1.2 Environmental Technican Procedures

The following procedures are to be used for the collection and submission of samples in the cumulative precipitation network. Technicians are to visit the monitoring sites at least once per month (exceptions for some sites due to travelling distances) to collect samples and maintain the instrumentation.

4.4.1.2.1 Instrument Checks

During the visit to a cumulative site the instrumentation is to be checked in the following way:

1. Activate the sampler with a wet finger. The hood assembly should immediately move to the dry side. The hood movement should be relatively smooth with only a small amount of play after the hood begins to drop to the dry side. Check the cleanliness and temperature of the sensor grids. Replace the printed circuit board if the grids are too hot or cold.

2. After the hood makes good contact on the dry side limit switch, the motor should turn off. The hood should remain on the dry side for approximately 2 minutes ($\pm$ 30 seconds). Check the placement of the wet bag to verify that it has been inserted properly.

3. The hood should return to cover the wet bucket after the 2 minute delay period and should completely seal the bucket before the motor stops.

4. Remove one sensor grid and insert the sensor grid with the 220 kΩ resistor. The sampler should activate and move to the dry side. If not, remove the "resistor" sensor grid and take the cover off the instrument. Turn the sensitivity trim pot located on the top of the printed circuit board clockwise until it can no longer be turned. Insert the "resistor" sensor grid and slowly turn the trim pot counter-clockwise until the instrument is activated. Leave the trim pot in this position.

5. Turn the power off and check the inside of the instrument. The switches should move smoothly and should not be deformed in any way. Check to make sure the P.C. board is securely in place.

6. Check the ground fault. Test it to ensure correct operation.

7. Place a level on the North-South and East-West axes points of the wet bucket to ensure the collection surface is level. (Note: Place a clean polyethylene bag over the bucket to avoid contamination.)

8. Check the nipher gauge to make sure it is level and that the thermometer is in good working order.

9. Check the monitoring site to identify any changes which might have taken place since the last visit. If there are site changes, fill out a "Notice of Site Changes" form. Detailed procedures for identifying site changes are in the Quality Assurance Manual (1).

Refer to the Preventive Maintenance Section 4.5 for routine servicing.

4.4.1.2.2 Log Books

An instrument log book (Figure 8) is to be maintained for all cumulative precipitation collectors. All instrument checks, adjustments, calibrations, repairs, and other relevant comments should be entered into the log book under the appropriate heading. All preventive maintenance should be entered. The log book is to remain with the instrument when it is shipped to Toronto for major repairs. A carbon copy of the instrument log book sheet is to be sent to the Technical Co-ordinator upon completion. Copies of these logs are shown in Figures 6 to 9.

The technician is responsible to ensure every operator maintains an operator log book. Check the log book on alternative visits to verify that good records are kept on sample dates, times, instrument checks and measurements. Inform the operators that entries in the log book are required to document all sample information during the collection period.

4.4.1.2.3 Supplies

The technician is responsible for ensuring that every operator has sufficient supplies according to section 4.4.1.1.11 "Operator Supplies". A supplies requisition

form (Figure 10) is to be filled out every six months and sent to the sample co-ordinator at the headquarters who will order and distribute the appropriate supplies.

The following is a list of spare parts that technicians should have on supply to maintain their instrumentation. These supplies are based on maintaining five precipitation collectors.

1 spare precipitation collector
2 printed circuit boards
4 sensor grids
2 capacitors
1 motor
1 transformer
10 limit switches
20 gaskets
1 thermometer

4.4.1.2.4 Operator Liaison

The same procedures apply as described in Section 4.3.1.2.4.

4.4.1.2.5 Sample Handling

The technicians should immediately check all samples at the monitoring sites for leaks and transfer or re-seal the bag if any samples are leaking. Check the operator sample record sheets to make sure they are completely filled out. Every sample should then be carefully placed in an upright position into a cooler (or suitable storage container). The cooler is to be placed in a stable area of the vehicle. Once the samples are brought into the regional offices, excess air should be forced out of the bags and then double sealed (if not already sealed at the site) before refrigerating. The seal should be made approximately ½ inch below the point at which the bag was cable-tied.

4.4.1.2.6 Weighing of Samples

Samples must be weighed prior to shipping to the laboratory. The scale is to be re-zeroed using the zero adjust knob on the bottom left side of the scale. Place the sample onto the scale and read off the weight in grams (digital readout). Subtract the weight of the bag (average short bag is 37 grams, long bag is 77 grams) and record the weight as the total volume in milliliters (mls) on the field submission sheet (assume 1 gram is equivalent to 1 ml.). Calibrate the weighing scales quarterly following procedures in Section 4.6.2.

4.4.1.2.7 Field Submission Sheets

A field submission sheet is filled out for every cumulative precipitation sample submitted. The following outline describes the format for filling out these sheets (called APIOS Wet Deposition Field Submission Sheet - Figure 11).

SAMPLING INFORMATION

Field Sample Number: Affix a field sample number which corresponds to the same sample number on the sample bag.

Collection Period: Enter the code "1".

Instrument: Enter the code "1".

Sample Type: Enter the code "1".

Station Number: Enter the corresponding station number. Every co-located instrument has a unique station number. Blank bags are coded 3092 with the region name written in the "comments" section.

Methodology: Enter a "1".

Sampling Start: Enter the day and time the sample bag was inserted into the bucket. The following entries are to be used for quality assurance samples.

Composites: The sampling start date is the handling date of the composite sample.

Blank Bags: The sampling start is the day and time the bag was sealed before shipping for analysis.

Sampling End: Enter the day and time the sample bag was removed from the bucket. Special cases for quality assurance are:

Composites: The sampling end is the day and time the composite sample was handled by the operator. This day and time should be the changeover date and time.

Blank Bags: The sampling end is the same date as the sampling start.

Bag In: Not applicable to cumulative wet samples.

PRECIPITATION INFORMATION

Type of Sample Submitted: Enter the appropriate code.

Precipitation Time: Not applicable to cumulative wet samples.

Volume: Enter the total volume of the sample determined by weighing.

28-day Gauge Depth Measurements: Enter the gauge depth (mm) measured by the operator.

Temperature: Enter the temperature ^{o}C (+ or -) of the gauge solution.

Gauge Depth: Enter the gauge depth calculated for the sampling period (mm).

Supplementary Depth:	If applicable.
Gauge Type:	Enter the appropriate code.
Malfunction Details:	Enter the inclusive dates of the sampler malfunction.
Field Comments:	Enter the appropriate codes.
Remarks:	Enter any remarks or comments which could have affected the sample during the sampling period. For all quality assurance samples, indicate the type of QA sample.
Station Name:	Enter the station name.
Operator:	Enter the initials of the operator.
Submitted By:	Enter the technician's name.

4.4.1.2.8 Sample Shipment

After processing, the samples are placed upright into a cooler with ice packs and packing material (bubble pad) and shipped via a courier to the Resources Road laboratory in Toronto. Field submission sheets are to be enclosed in a plastic bag and placed in the cooler with the samples. The samples should never be shipped on a Friday due to the possibility of the coolers sitting over the weekend without refrigeration. Upon receipt of the samples at the laboratory, the coolers are immediately placed into the walk-in cold room (4°C) located in the sample reception area.

4.4.1.2.9 Changeover Procedures

During the summer sampling period shorter sampling bags are used to collect precipitation samples. For the last sample change in April, inform the operator to insert a short sampling bag into the long sampling tube.

The nipher shield is to be removed for the summer sampling period at the end of March (for NW region, end of April). To prevent freezing of the nipher gauge solution during the winter period, a 40% ethylene glycol/60% methanol solution is added into the gauge. This solution causes water, when added, to sink. Any amount of water added to the 60% methanol/40% ethylene glycol solution will always produce a solution less dense than water thereby encouraging mixing.

If the methanol - ethylene glycol solution exceeds 70% methanol, ice and snow will sink to the bottom of the gauge and a frozen layer will form. If the solution is less than 50% methanol, the self-mixing action will not occur and a capping layer of ice will form at the top of the solution. It is <u>important</u> that the ethylene glycol - methanol solution be carefully prepared and maintained.

The addition of water to the methanol - ethylene glycol solution does not affect the mixing action in the gauge until the solution reaches 60% water. At this point for colder temperatures, a crystalline mush will form. This 60% criterion along with seasonal precipitation averages allows the calculation of the amount of solution necessary to ensure the gauge to function properly through the winter. At some stations where precipitation can vary greatly, the gauge needs to be checked through the winter to ensure the contents will not overflow the gauge. These stations are generally located in snowbelt areas where seasonal precipitation averages can very greatly.

A layer of transmission fluid 0.75-1.0 inches thick will be used to prevent evaporation of the solution. For the nipher gauge approximately 250 mls. (1/4 litre) of transmission fluid is necessary to provide this capping layer.

Depending on what the solution temperature is, the density can vary up to 5%. This can result in serious problems in the calculation of precipitation depths if the density changes are not taken into account. It is therefore necessary to record the solution temperature whenever a gauge measurement is taken in order to correct for the density difference. This correction will be performed by the technician on a gauge record sheet (Figure 15) after receipt of the sample information from the operator.

Nipher Gauge Charging Procedures

As close as possible to the first changeover date in November, charge the gauge following these procedures.

1. Measure the depth in the gauge of the existing water and transmission fluid mixture and calculate the precipitation depth thus far for that month. This value should be entered into the operator's log book and on the gauge record sheet. This value is to be added to the change in depth which occurs during the period after the charging date till the next reading.

2. Skim the transmission fluid out of the gauge into a suitable container and dispose of it at a local garage. Empty the remaining water.

3. Fill the gauge with approximately 3 litres of 60% methanol, 40% ethylene glycol solution. Note: Use eye protection and protective gloves when filling the gauge.

4. Add 1/4 litre of transmission oil.

5. Very carefully take a depth and solution temperature reading and record these as Reading No. 1 on the gauge record sheet.

Gauge Depth Calculations

During the winter sampling period, a temperature must be taken of the gauge solution to correct the depths for changes in the density of solution. The following instructions are provided for calculating precipitation depths during the winter sampling period. Also provided is an explanation of terms used in these calculations.

Reading No. - Consecutive numbering of readings taken. (usually on a 28 day basis)

- The initial charge depth is always used in the calculation of the percentage of water.

Solution Depth - Is the recorded depth in the gauge. Recorded by operator.

$$\% \text{ water} = \frac{\text{Solution depth} - \text{Charge depth}}{\text{Solution depth}} \times 100$$

Solution Temperature - Is the temperature of the solution in the gauge.

Solution Density - Is deduced from the density graph using the solution temperature and the calculated % of water.

Water Equivalent - Solution Density x Solution Depth

- For the solution in the gauge, this is the depth of an equivalent amount of water.

Precipitation - Will be past month's precipitation amount.

- Calculated from past month's water equivalent minus the previous month's water equivalent.

Instructions for determining the precipitation depth

1) The initial solution depth should be entered on the gauge record sheet when the gauge is charged.

2) Transfer the date, solution depth, and solution temperature from the operator sample record sheet to the gauge record sheet.

3) Calculate the % of water as shown on the gauge record sheet and enter this percentage in the column. Note that the charge depth is equal to the first solution depth recorded.

4) The solution density can now be obtained from the density graph (Figure 16), using the % of water and the solution temperature. For a point lying between two density lines interpolation is necessary. Record this value on the record sheet. An example is shown on the graph: For a temperature of -10°C at a water concentration of 20%, the density is 0.987 kg/l.

5) The water equivalent can then be calculated by multiplying the solution density by the solution depth. This value is recorded to the nearest tenth of a centimeter.

6) To obtain the month's precipitation amount subtract the previous month's water equivalent from the water equivalent calculated in step 5.

7) This value should be recorded on the gauge record sheet and on the field submission sheet.

During the spring changeover to summer sampling methods (end of March), the gauge is to be emptied and re-charged with about 100 mls. water and a 250 mls. capping layer of transmission oil.

Empty the methanol/ethylene glycol solution into containers which are labelled indicating the contents and hazards. Dispose of this solution by taking it to the approved storage site in your region (Regulation 309) where proper disposal procedures are in effect. When emptying this solution always wear approved eye protection and protective gloves.

4.4.1.2.10 Quality Control/Quality Assurance Procedures

Similar procedures to that of the event precipitation network will be carried out in the cumulative precipitation network. The following is a description of these procedures.

4.4.1.2.10.1 Procedures Audit

Annually, field technicians are to carry out a performance audit of the operator's handling procedures. This audit is to consist of observing the operator remove and insert new bags, clean the instrument, take nipher gauge readings, and observe any other procedures which are to be followed for the collection (see the Quality Assurance Manual) of samples. Because of the complexities of scheduling these audits on sample changeover days, it may become necessary to improvise by having the operator insert and remove a bag in a spare bucket and collar or by relying on verbal descriptions of the operator's duties. This method is preferable to temporarily removing samples from the collector to carry out the audits.

During the audits, allow the operator to carry out all the procedures even if they may deviate from standardized procedures. Record these differences and only after the completion of the audit identify them to the operator as well as stressing the importance of using standard procedures. The audits are not "pass" or "fail" situations; they are a means of ensuring that the same procedures are used by everyone in the program. Note that the procedural audits can be carried out simultaneously using the composite samples described in the next section if the audit is carried out on the sample changeover date.

4.4.1.2.10.2 Composite Samples

Composite samples will be handled by the operator on a annual basis and submitted for analysis following standardized procedures. Technicians will receive

polyethylene bottles containing a 1 litre composite of precipitation which is to be given to the operator. Prior to distributing the composites, technicians are to initially weigh the composites and record the sample volumes under the heading "Remarks" on the field sheets. After the composite samples are handled by the operators, the final volumes are to be determined and recorded onto the field sheets under the "total" volume boxes. The composite is to be stored where the operator normally stores the regular sample. On the next sample changeover date the operator is to remove the sample and insert new sampling bags as normal procedures dictate. The composite sample is then immediately poured into the sampling bag. The composite sample is to be immediately removed and submitted as a normal precipitation sample. A wet bag is placed back into the bucket. Technicians are to code the composite samples as "composite" under the heading "Type of Sample Submitted" on the field submission sheets.

4.4.1.2.10.3 Co-located Sampling

At one cumulative site in every region, co-located instrumentation will be operated to provide overall estimates of precision. This co-located instrumentation will include a precipitation collector and nipher gauge. Unique station numbers are to be used for submitting co-located samples to the laboratory.

4.4.2 Cumulative Air Sampling Network

4.4.2.1 Operator Handling Procedures

Low-volume air sampling is a method to estimate dry deposition. This air sampling method utilizes filter packs using selective filters to collect specific pollutants over a 28 day period. The flow rate of the low volume air sampler is two litres per minute. Every 28 day period when the sampling bags are removed from the precipitation collector, the filter pack is to be removed and a new filter pack installed. The technician responsible for the site will leave a loaded filter pack for the upcoming month to replace the pack which is removed. The following is a description of the procedures to be followed for those operators with these air samplers.

4.4.2.1.1 Deployment of Filter Packs

1. Check the flow rate. The flow rate should be set at 2.0 litres per minute or a flow rate determined by a calibration by the technician. Record this flow rate as the "OFF" flow rate in the log book and sample record sheet.

2. Turn off the sampler. Record the total volume and elapsed time from the digital counters. After recording these counters, re-zero both of them by depressing the buttons beside each counter.

3. To remove the filter pack, fit a new Whirlpak bag supplied with the new filter pack over the bottom of the pack and remove by turning counter-clockwise. This procedure will prevent potential filter contamination by eliminating any contact with the hands. Tie the Whirlpak bag squeezing any excess air out of the bag.

4. Install the new filter pack following the same procedures above except threading in a clockwise direction. Use the Whirlpak bag in which the filter pack had been stored to prevent possible hand contamination as in step 4. The filter pack should be threaded snugly to prevent any leaks developing in the connection to the baseplate.

5. Turn the instrument back on. The counters should have been re-zeroed as in step 3. The flow rate should be 2.0 litres per minute or a flow rate which has been determined by the technician from a calibration. If necessary, adjust the flow and then record the flow as the "ON" flow rate in the log book and operator record sheet. All flow adjustments should be recorded on the sample record sheet and entered into the log book.

4.4.2.1.2 Instrument Checks

The low-volume air sampler should be checked every week simultaneously with the precipitation collector checks. The flow should be checked and adjusted if necessary. The counters should be checked to verify that they are advancing properly. Any adjustments or observations (e.g. burning grass September 3, 1982, filter looks wet, etc.) should be entered into the log book and sample record sheets. If it is noticed that the pump seems noisier than usual or the flow drops consistently, notify the technician of these observations since it may be necessary to replace the unit.

4.4.2.1.3. Operator Sample Record Sheets

The following sampling information is to be recorded on the sample record sheet for every low volume filter pack.

Lo-Vol Sampler Measurements

Volume Sampled: Enter the total volume sampled as indicated by the volume counter on the front panel of the instrument.

Elapsed Sampling Time: Enter the total amount of time (in hours) the instrument ran as indicated on the time counter (eg: 671.39).

Sampling Flow Rate On: Enter the flow rate when the new pack was installed.

Sampling Flow Rate Off: Enter the flow rate when the pack was removed.

If the flow rate required an adjustment indicate this on the sample record sheet. Enter the date and time of the adjustment and enter the flow rate before the adjustment was made.

4.4.2.1.4 Operator Log Book

Enter into the log book the date and time the pack was changed, the on and off flow rates, and the volume and time digital readings. Any observations which could affect the integrity of the filter pack should be recorded. If the flow rate required an adjustment, record the date and time of the adjustment as well as the flow rate before the adjustment was made.

4.4.2.1.5 Supplies

Every operator should have a loaded filter pack prior to every changeover period.

4.4.2.1.6 Quality Control/Quality Assurance Procedures

The following procedures are to be implemented on a regular basis.

4.4.2.1.6.1 Procedures Audit

Annually the field technician will observe every operator install and remove a filter pack. Log books will be reviewed to ensure they are complete and up-to-date. The technicians will review, with the operator, all operating procedures to ensure that standard procedures are followed.

4.4.2.1.6.2 Co-located Sampling

At one cumulative site in every region, a co-located low volume air sampler will be installed. For a co-located filter pack sample, write on the Whirlpak bag containing the pack, "Co-located".

4.4.2.2 Environmental Technician Procedures

These procedures are to be followed for collecting samples in the cumulative air sampling network. Technicians are responsible for loading the filter packs and distributing these packs to their operators. Exposed filter packs are unloaded by the technician and filters are then submitted to the laboratory. The filter packs are washed after every sampling period prior to loading for the next sampling period.

The instrumentation is to be checked to ensure proper operation during every site visit. Preventive maintenance and calibrations are to be carried out following sections 4.5 and 4.6.

4.4.2.2.1 Loading and Unloading of Filter Packs

The loading of filter packs follows the same procedures established in the event air sampling network, Section 4.3.2.1.2. The only exception to these procedures is the type of pre-filter used. A Whatman-40 filter is used instead of a teflon filter to collect particulates. This change is required because of the higher loading over a 28 day period which brings about an undesirable pressure drop in the teflon filter.

The loaded pack is placed into a new Whirlpak bag and twist tied. This pack is then sealed inside a zip-loc bag along with a new Whirlpak bag which will be used by the operator to remove the exposed filter pack. This new Whirlpak bag should also be labelled with the station name and sampling date to avoid confusion in identification. The exposed pack is to be twist tied and placed back into the zip-loc bag. The new loaded pack is threaded onto the baseplate for the next 28 day sampling period.

The technician will pick up the exposed pack and unload it at the regional office following the same procedures used in the event air sampling network,

Section 4.3.2.1.4. The filters are individually placed into Whirl-pak bags. All the filters for one pack are then placed into another new Whirl-pak bag with a label identifying the station name, number, and sampling period. Affix the field sample number to the label and affix the duplicate field sample number to the field submission sheet. The filters for submission should be enclosed in a sealed plastic bag with the corresonding field submission sheets. Submission sheets are to be filled out following instructions given in the next section.

4.4.2.2.2 Field Submission Sheets

A field submission sheet (Figure 13) is filled out for every filter pack submitted for analysis. Use only a black pen and fill out the sheets legibly. The field submission sheets are to be shipped with the filters to the laboratory.

Field Sample Number: Affix the duplicate field sample number which is fastened to the Whirlpak bag containing the filters.

Collection Period: Enter the code "01".

Instrument: Enter the code "22".

Sample Type: Enter "21".

Station Number: Enter the station number. Note that co-located instruments have unique station numbers.

Methodology: Enter the code "01".

Sampling Start: Enter the date and time the pack was installed and exposed.

Sampling End:	Enter the date and time the pack was removed.
	Note: For handling and filter blanks, the sampling start and end dates are the dates the filter pack was handled (i.e. loaded and unloaded).
Sampling Port Number:	Leave blank (applicable to daily samples only).
Filter Use:	Enter a "1" for regular monitoring. If the instrument malfunctions, still enter in the code "1". If the filter pack is a handling blank enter a "3". Filters submitted from the headquarters for blank analysis are coded "4" specifying "Blank" beside the "Other" coding.
Volume Sampled:	Enter the volume in litres recorded by the instrument's volume counter (x 10 litres).
Volume Correction:	This correction is the error, expressed as a percentage, of the volume sampled. Enter above the "Corrected Volume" this percentage error (to the nearest unit) determined by the last calibration and include whether it is a negative or positive percentage error (i.e. +5%, -5%).
Corrected Volume:	Enter the corrected volume in litres using the volume sampled and volume correction factor.
Rotameter Reading:	Enter the flow rates (litres/minute) recorded for the sampling start and end periods.
Elapsed Sampling Time:	Enter the elapsed time from the time counter on the instrument (in hours).
Filters Submitted:	Indicate a "1" for each type of filter that is submitted under the field sample number.

Associated Passive Number(s):	Applicable to daily samples only.
Associated Batch Numbers:	Enter the batch numbers for each filter submitted. The batch numbers are those codes on the outside of the filter storage containers or filter storage bags received from the headquarters.
Field Comments:	Enter the appropriate codes if applicable.
Special Remarks:	Enter any comments or observations which might have affected the integrity of any filters in the pack. For quality assurance samples, specify the type and location of this sample.
Station Name:	Enter the station name.
Operator's Name:	Enter the initials of the operator who changed the pack.
Submitted By:	Technician's name is entered.

4.4.2.2.3 Instrument Checks and Log Book

During every visit to the monitoring site, the following instrument checks should be undertaken.

1. Check the flow rate on the rotameter. The flow rate should be set at the flow calculated from the last calibration to correspond to 2.0 litres per minute.

2. Check the volume and time counters. Roughly calculate the number of hours which have actually elapsed since the packs were deployed. This estimate should be multiplied by 120 (2 lpm x 60 min. per hour) to determine if the volume counter is functioning properly.

3. The pump should not be labouring in any way. It should sound smooth and consistent.

4. Check all external tubing connections and ensure the pack is properly fastened to the baseplate. To check for leaks remove the filter pack from the baseplate and plug the baseplate inlet with a finger. The flow should drop to zero.

5. Ensure the sampling pole is secure and level. Adjust the turnbuckles if required.

6. Perform preventive maintenance as required following the schedule in Section 4.5.

Instrument log books should be maintained in the same manner as Section 4.3.1.2.2. Copies of the completed sheets showing all checks, calibrations, and preventive maintenance are to be sent to the Technical Co-ordinator.

4.4.2.2.4 Quality Control/Quality Assurance Procedures

The same procedures which are required by the event air sampling network, Section 4.3.2.1.7 apply to the cumulative air sampling network.

4.5 Preventive Maintenance

The following procedures and checks have been incorporated into the monitoring networks to keep down-time to a minimum. The program is broken down according to the cumulative and event monitoring networks. Routine instrumentation checks have already been incorporated under the sections entitled "Instrument Checks" located throughout the manual.

4.5.1 Event Network

1. Aerochem Metrics Precipitation Sampler: The following maintenance is to be carried out.

Sensor

- Once every month wash the sensor with ethanol. Check the sensitivity across the trim potentiometer. The resistence should be 12 kΩ during the summer months and slightly higher (14 kΩ) during the winter.

Hood Gasket

- Replace the hood gasket every 3 months.

Cleanliness

- The buckets and instrument body should be cleaned as required using ethanol and Kimwipes.

Power Source and Connections:

- The ground fault and all electrical wiring and connections are to be tested or checked every month.

2. Metrex Sequential Air Sampler:

Sequential Sampler

- Inspect all internal tubing, contacts, and connections every 2 months. Replace the in-line filters (vacushields) on the sampling ports every 3 to 4 months.

Pump

- Overhaul the pump every 6 months. Replace the diaphragm, cover gasket, filter sponges, and flaps. Clean the pump filler bowl and intake fan every 6 months.

Tower and Hardware

- Replace the sample line tubing every year. Check all tubing and baseplate connections every month. Keep the filter housing shelter clean at all times. Tighten the boom couplings every year.

4.5.2 Cumulative Network

1. Sangamo or M.I.C. Type A Precipitation Collector:

Limit Switches

- Replace every 4 to 6 months.

Limit Screw Adjustments

- Check every month. Ensure that the switch is sufficiently depressed after initial contact by the limit switch screw.

Chain Tension

- Visualiy check and adjust if required. The chain is to be lubricated once every year with a fine oil (not grease). There should be approximately 1/4 to 1/2 inch of play in the chain. Overtightening causes "pings" while undertightening causes the hood to drop.

Clutch Adjustment

- The clutch should be adjusted to approximately 15-20 lbs using a spring gauge. Check this adjustment every 3 months.

Sprockets

- Check the small and large sprockets every 3 months for correct alignment. Tighten the set screw on the small sprocket (if applicable) every month.

Set Screws and Expansion Pins

- If the hood shows any sign of dropping, the set screws are to be tightened or the expansion pin is to be replaced. (Note: Also check for proper chain tension.)

Transformer

- Check the transformer output every 6 months. It should be approximately 12.5 to 15 Volts A.C.

Motor

- Ensure the grease plugs are firmly in position preventing any leakage of grease. Every 6 months lubricate the motor (only on M.I.C. type A) with a few drops of an SAC-30 non-detergent type oil.

Hood Gasket

- Check every month for cleanliness and wear. Replace the gasket every 3 months.

Sensor Grids and Sensitivity

- Check the temperature of the sensor grids. They should not be too hot or cold, otherwise replace the printed circuit board. Ensure that the sensor grid thermistor and heater grid element are completely encapsulated in epoxy. Clean the sensor grid pin contacts every 6 months (use sand paper or file). The delay time of the P.C. board should be between 1.5 to 2.5 minutes. The grids should be clean at all times. Set the sensor sensitivity using the 220 kΩ resistor and check every month. Note that 2 functioning sensor grids are required at all times to prevent damage to the P.C. board.

Printed Circuit Board

- Ensure that the board is properly seated.

Cleanliness

- The instrument housing and sampling bucket should be clean at all times. The internal housing should be relatively clean.

Power Source and Instrument Wiring

- All connections and internal wiring should be checked every 6 months. Test the electrical ground fault every month.

2. Metrex Low-Volume Sampler:

Pump - Overhaul the pump every 6 months. Replace the diaphragm, cover gasket, filter sponges, and flaps. If a pump becomes noisy, replace it as soon as possible.

Power Source and Wiring

- Check the internal wiring and tighten all connections every 3 months.

Tower and Hardware

- Replace the sample inlet tubing every year. Replace the in-line filter (Vacushield) every 3 to 4 months. The tower should be straight and upright at all times. The low-volume sampler stand should be levelled when required.

4.6 Calibrations

The following calibration procedures are to be implemented to continually ensure the precision and accuracy of all instrumentation, test equipment and calibration standards used in the monitoring networks. Results of these calibrations are to be immediately sent to the Technical Co-ordinator. Copies of all calibrations are to be kept in the instrument log books. Any equipment which does not meet the acceptable accuracy limit is to be repaired or removed from the field program and replaced. Procedures are described according to the event and cumulative monitoring networks. Mass flowmeters used in all calibrations are to be checked yearly for accuracy by an approved standard or reference.

4.6.1 Event Network

Sequential Air Sampler:

The sequential air sampler is to be calibrated semi-annually using a mass flowmeter to determine the accuracy of the rotameter and temperature compensated dry gas meter. The digital volume counters are to be within $\pm$15% of the actual volume measured by a mass flowmeter. The following procedures are to be used for calibrating the sequential air sampler.

Equipment required:

- Mass flowmeter and transducer with proper range
- Digital multimeter (optional)
- Timer (stop watch)
- Graph paper and calibration sheets

1. Plug in the mass flowmeter and allow it to warm up for 10-15 minutes.

2. Make sure the transducer's serial number matches the mass flowmeter's serial number.

3. Connect the transducer to the inlet on the back of the sampler. Make sure that the flow direction indicated on the transducer is correct. Connect the multimeter (if available) to the mass flowmeter.

4. Enter the descriptive information required on the air sampler calibration sheet (Figure 17).

5. Set the mass flowmeter to 20 lpm by adjusting the flow and record the corresponding flow rate on the sampler rotameter.

6. Zero the volume counter and run the instrument for at least one hour. Record the elapsed time and the observed volume on the digital counter. Calculate the true volume by multiplying the mass flowmeter flow rate by the number of minutes elapsed. The digital volume should be within $\pm$15% of the true volume. This percentage difference is to be recorded and applied to all sampled volumes on all field submission sheets.

7. Check the linearity of the rotameter by setting the mass flowmeter at 10, 15, 20, 25 litres per minute and recording the flows of the rotameter at each setting. Allow the mass flowmeter to stabilize after adjusting to a new flow rate. Graph the rotameter flow rate against the mass flowmeter flow rate.

8. Set the mass flowmeter to 20 lpm and sequence through the other ports recording the flow rate for each port. Allow the mass flowmeter to stabilize between every port.

9. Send a copy of the calibration sheet and graph to the Technical Co-ordinator and keep another copy in the instrument log book.

pH Meters:

Calibrate the pH meters following the procedures described in Section 4.3.1.2.6., Field pH Measurements.

Weighing Balances: (see next section)

4.6.2 Cumulative Network

Low-Volume Air Sampler:

The low-volume air sampler is to be calibrated semi-annually using a mass flowmeter. The digital volume counter is to be within ±15% of the true volume measured by a mass flowmeter and transducer. The equipment required for a calibration is the same used to calibrate the sequential air sampler. Follow the same procedures in the sequential calibration except replace steps 5 to 9 with the following.

5. Set the mass flowmeter to 2 lpm by adjusting the flow and record the resultant rotameter flow rate. Make sure the mass flowmeter has stabilized at the 2 lpm flow rate.

6. Zero the volume and time counters and run the instrument for at least 4 hours (preferably a 24 hour period if performed in the lab). Record the actual time elapsed and record the volume and time counters. Calculate the true volume sampled by multiplying the mass flowmeter flow rate by the number of minutes elapsed. The digital volume counter should be within ±15% of the actual volume sampled. The percentage difference is to be recorded on all field submission sheets and the total volumes for filters are to be corrected.

7. Check the linearity of the rotameter by setting the mass flowmeter to 1.0, 1.5, 2.0, 2.5, 3.0, and 4.0 lpm and recording the corresponding rotameter flow rates. Allow the mass flowmeter to stabilize after each flow rate. Graph the mass flowmeter flow rate against the rotameter flow rate for these points.

8. Send a copy of the calibration sheet (Figure 17) and graph to the Technical Co-ordinator and keep another copy in the Instrument log book.

Precipitation Sample Weighing Balance:

Digital weighing balances are used in the precipitation networks to determine the sample volume prior to shipment to the laboratory. These balances are to be calibrated every six months using weights referenced to the National Bureau of Standards.

1. Re-zero the scale.

2. To calibrate, place the following weights onto the scale and record the resultant digital readouts.
   5g, 10 g, 100 g, 1 kg, 2 kg, 5 kg

3. Fill out the calibration sheet (Figure 19) and submit a copy to the Technical Co-ordinator and keep one copy in the instrument log book.

5.0 SAMPLING ANALYSIS

5.1 Sample Reception and Preparation

The following section describes the sample reception and preparation in the laboratory.

Event Precipitation Network:

Event samples in bottles and field submission sheets are received at the Resources Road laboratory in coolers with freezer packs. They are immediately placed into a walk-in refrigerator at 4°C.

Samples are checked against the appropriate field submission sheets by matching field sample numbers. Field submission sheets are then scanned for possible errors. The samples are recorded in a record book and given a laboratory submission number. Regional location(s), type of sample, program applied to sample (i.e., Special Studies, APIOS), date submitted to lab, and a listing of field sample numbers are all recorded under the submission number in the record book. Samples from more than one region may be entered under the same submission number. Field submission sheets are each assigned this submission number.

Laboratory submission sheets (Figure 20) and request for analysis forms (Figure 21) are filled out and photocopied. The photocopies are given to the APIOS database clerk for filing. The samples and original forms are given to the laboratory sample reception for processing. The samples are assigned lab sample numbers, entered into the laboratory information system (L.I.S.), and sent to the precipitation lab for analysis. A flow diagram of the laboratory sample handling procedures for event samples is provided in Figure 22.

Note: Samples with less than 35 mls but greater than 10 mls are diluted at the lab and submitted for analysis. If a sample is to be diluted, a new sample bottle is placed on the balance and tared. The sample is poured into the new bottle and weighed. The new volume is recorded on the field sheet. The sample volume is then brought up to 40 mls by adding DDW.

Event Air Sampling Network:

Air filters with field submission sheets are received together from individual regions. Field sheets are sorted in order of dates and scanned for possible errors. Samples and field sheets are assigned a submission number and the appropriate information is recorded in the record book (for record book details see 5.1.1.1).

Submission forms are photocopied and given to the database clerk, along with the field submission sheets for filing. The filters and submission sheets are recorded in a log book in the precipitation lab and given to the technician for processing and analysis. A flow diagram of the laboratory sample handling procedures for air filters is provided in Figure 23.

Cumulative Precipitation Network:

Sealed cumulative sample bags are received in coolers along with the corresponding field submission sheets. A submission number is assigned and recorded on each field sheet with appropriate information being recorded in the record book (see Section 5.1.1.1). More than one region may be included in a particular submission. The submission sheets are photocopied and a copy is given, with the original field sheets, to the database clerk. The samples and laboratory submission sheets are given directly to a technician in the precipitation lab. A flow diagram of the handling procedures is provided in Figure 24.

Cumulative Air Sampling Network:

Cumulative air samples are received on a 28-day basis with the corresponding field submission sheets. They are stored until all regions' filter samples for a 28-day sampling period have been received. The samples are then logged into the record book (see Section 5.1.1.1) and assigned a laboratory submission number. Each field sheet is given this submission number.

A covering submission sheet and the accompanying request for analysis forms are completed and photocopied. The original copies along with the filters are again logged in at the precipitation lab and given directly to the senior technician. The photocopies along with the field sheets are given to the database clerk at the headquarters for filing.

5.2 Analytical Methods

The following sections describe the analytical methods used by the laboratory to analyse samples collected in the APIOS deposition program. Provided in Tables 4 to 8 are the laboratory analytical methods for all parameters.

5.2.1 Event Precipitation Network

The event precipitation samples are analysed for the following parameters (listed in descending order of priority): Conductivity and pH, acidity, $SO_4^=$, $N\text{-}NO_3^-$, Cl^-, $N\text{-}NH_4^+$, Na^+, K^+, Ca^{++}, and Mg^{++}.

Volume:

The volumes of event samples are determined in the field by the environmental technicians using a digital balance. The volumes are entered onto the laboratory request for analysis forms to determine analysis priorities.

pH and Acidity:

pH is measured directly as the millivolt potential established in an electrode chain consisting of a hydrogen ion sensitive glass electrode and a calomel reference electrode immersed in the sample under test.

Precipitation samples are titrated automatically with standard sodium hydroxide (~0.01N) to a pH greater than 8.75 using a microcomputer, digital pH meter, and an autoburette. A Gran acidity is calculated from the titration data. Titrant normality is determined by titration against a standard 0.005N potassium hydrogen phthalate solution. The titrant delivery rate is controlled by the first derivative of the titration curve and by the stability of pH readings following each aliquot of titrant.

Chloride, Nitrate and Sulphate:

Using a modified Dionex ion chromatograph chloride, nitrate and sulphate may be measured simultaneously.

The anions are separated in a separator column by reaction with an ion exchange resin and an eluent. After separation the anions enter a suppressor column where they are converted to their acid forms. The sodium carbonate-bicarbonate eluent becomes carbonic acid. As each anionic species comes off the suppressor column a conductivity meter measures their conductivity. The

conductivity of the eluent is insignificant in comparison with the conductivity of the species measured. The conductivity measurement of each anion is interpreted through the peak height on a chart recorder. Each anion is identified by its retention time from comparison to known standards. The results are reported as mg/l.

Ammonia:

Ammonia is determined by the automated phenate-hypochlorite method. The procedure is based on the formation of an indophenol blue product in buffered alkaline media and includes a blanking system to compensate for the sample matrix. In the colour formation stream, ammonia is converted to indophenol blue using sodium nitroprusside as a catalyst. The blanking stream differs from the colour formation stream in the respect that the flow of the catalyst reagent is replaced by an equal flow of deionized distilled water. Two analytical ranges are obtained from the output signal of the colorimeter.

The results are reported as mg-N/l. The ammonia fraction can be calculated from the temperature, pH, and the reported result of the sample.

Sodium, Potassium, Calcium, and Magnesium:

Each of these cations are measured by automated atomic absorption spectrophotometry. The sample under test is automatically mixed with a releasing agent, characteristic to each cation, and aspirated as a fine mist into an air-acetylene flame of an atomic absorption spectrophotometer. A hollow cathode lamp, specific for each separate cation, emits light at a characteristic wavelength of the cation being measured. The light is directed through the flame into a monochromater and onto a detector. The cation atoms heated in the flame absorb this light and the detector measures the decreased intensity of the resulting beam. The amount of light absorbed is directly proportional to the concentration of cation in the sample, and is recorded on a stripchart as a series of peaks. Results are calculated through comparison of these peaks to a calibration curve derived from simultaneously tested standards.

Conductivity:

A Radiometer CDM3 conductivity meter and a CDC 324 jacketed conductivity cell are used to determine conductivity. A sample is aspirated by suction into the cell which is maintained at 25°C by a circulating water

bath. The meter has a compensating circuit for the cell factor. The reading is multiplied by the appropriate power of ten to give conductivity in micromhos/cm.

5.2.2 Event Air Sampling Network

Teflon Filters:

Teflon filters are extracted with 50 ml of distilled deionized water for 20 minutes in an ultrasonic bath. Analysis is performed by ion chromatography for $SO_4^=$ and $N\text{-}NO_3^-$, and for $N\text{-}NH_4^+$ by automated phenate-hypochlorite colorimetry. For instrument methodology refer to Section 5.2.1.

Nylon Filters:

Nylon filters are extracted with 25 ml of 0.003 N NaOH for 20 minutes in an ultrasonic bath. The extracts are analyzed for $N\text{-}HNO_3$ (as NO_3^-) and SO_2 (as $SO_4^=$) by ion chromatography. For instrument methodology refer to Section 5.2.1.

Whatman 41 Filters:

The two Whatman 41 cellulose filters from the same filter pack are extracted in the same beaker for 60 minutes in an automatic shaker with 50 ml of 0.05% (V/V) hydrogen peroxide. This is followed by a 20 minute shaking in 50 ml hydrogen peroxide which is made up to 100 ml with hydrogen peroxide.

Analysis is performed by ion chromatography for $SO_4^=$ and the results are reported as SO_2. For instrument methodology refer to Section 5.2.1.

5.2.3 Cumulative Precipitation Network

All cumulative precipitation samples are analysed for the following parameters: volume, conductivity and pH, total acidity, $SO_4^=$, $N\text{-}NO_3^-$, $N\text{-}NH_4^+$, Cl^-, Ca^{++}, Mg^{++}, Na^+, K^+, N-TKN (total Kjeldahl nitrogen), TP (total phosphorus), Zn, Fe, Ni, Cu, Pb, Al, Cd, Mn and V. The majority of the analytical methods have already been discussed in Section 5.2.1. Below is a description of methods not previously discussed.

Total Kjeldahl Nitrogen and Total Phosphorus:

Total Kjeldahl nitrogen is a measure of all the nitrogen present in the organic form (soluble or particulate) such as proteins, amines and nitrogen present as free ammonia. It does not include nitrogen present as nitrite or nitrate.

Basically, this total Kjeldahl nitrogen (TKN) procedure entails converting the trinegative nitrogen content of organic compounds to ammonium ions in an acid media, neutralizing, and then analyzing the sample for ammonia. Thus the TKN value also includes the original ammonia concentration. Both TKN and total phosphorus are determined on the same aliquot of sample. Via Kjeldahl's reagent (sulphuric acid, potassium sulphate, and mercuric oxide) 40 samples are digested simultaneously in a two-step pretreatment, concentration at 200°C and fuming at 360°C for 20 minutes. The integrity of the sample volume is restored, and the samples are presented to the AutoAnalyzer system where they are netralized in two stages. The pH of the highly acidic samples (0.3 - 0.6 N) is raised to approximately 1.5 units by an aklaline-salt solution; the sodium chloride content complexes the mercuric ions in Kjeldahl's digestant. The samples are then buffered to pH 12.3 with a 1.0 M phosphate buffer and metal ions are complexed with EDTA. Finally, the sample is analyzed for ammonia nitrogen by phenate-hypochlorite colorimetry with sodium nitroprusside as a catalyst. The absorbance of the blue indophenol species is measured at 630 nm using 1.5 cm flow cells. TKN results are determined from a chart recorded trace by comparison with peaks produced by undigested standards that contain appropriate quantities of the chemicals produced during the digestion step. Digested standards are utilized as recovery checks.

Metals Analysis:

The aqueous samples with sufficient volume (greater than 100 ml) are analysed for Zn, Fe, Ni, Cu, Al, Mn, V, Cd and Pb by ICP (Inductively Coupled Argon Plasma). For samples with limited volume (less than 100 ml) including Ni, Cd, and Pb, the GFAAS (Graphite Furnace Atomic Absorption Spectrophotometry) analytical method is used.

Sample bags are leached for 24 hours with 1000 ml of 5% HNO_3. A 25 ml aliquot of each sample is taken in a polyethylene tube for analysis of all elements except Zn by GFAAS. Zn is analysed by Flame Atomic Absorption Spectrophotometry. Both the sample and leach values are reported as concentrations in units of mg/l.

1. Inductively Coupled Argon Plasma (ICP):

Sample aliquots (100 mls) are concentrated first to 5 ml in polyethylene centrifuge tubes in an oven. The aqueous acid digestates are aspirated into an inductively coupled argon plasma. The plasma is extremely hot (9000°K), and thus totally disrupts any molecules, atomizes and excites all components in the samples. When the excited atoms and ions return to lower energy states, they emit light of very specific wavelengths. The wavelengths for each element are characteristic and well known. The coherent emitted light is separated by a diffraction grating. Phototubes are located at specific locations relative to the grating to intercept the wavelength for each analyte of interest. The photomultiplier counts are monitored under computer control and results are printed out in concentration. In contrast to atomic absorption, where elements are determined individually, here over 20 elements are determined on a single aspiration. Sensitivities and detection limits are comparable or superior to atomic absorption.

2. Graphite Furnace and Flame Atomic Absorption (GFAAS):

Atomic absorption spectrophotometry is an analytical technique for the determination of elements based on the absorption of radiation by free atoms. The production of atoms from a chemical compound requires the absorption of energy. The energy is usually supplied in the form of heat from a flame. The absorption of thermal energy from the flame, with a subsequent re-emission of the energy as a spectral line, corresponds to atomic emission. Atomic absorption corresponds to the absorption of energy from a source other than the flame (usually the signal from a hollow cathode lamp) with the subsequent decrease in the signal from the source. Prior to analysis the sample aliquot is digested, as described above in the ICP method. This preparation breaks down organic matter and solubilizes particulate. The resultant solution should be clear and colourless (as far as possible).

The basic difference between flame and flameless AAS is the atomization process is conducted in a resistively heated graphite tube in an inert atmosphere rather than a flame. The tube furnace assembly is placed in the burner chamber such that the hollow cathode source passes down the tube cavity. An aliquot of sample (usually 20 ul) is injected into the furnace via an autosampler through a small hole in the body of the tube.

The tube furnace is connected to a computer controlled power supply such that it can be electrically resistively heated under well controlled

conditions. The sample is dried, (100° for 20 sec.), ashed (700° for 30 sec.) and atomized (2500° for 8 sec.). The tube is contained in a cell flushed with argon to prevent cell burning and increase atomization efficiency. The high temperature volatilizes metal salts and oxides. These compounds are subsequently reduced in the vapour phase to atoms which are measured by conventional AAS as described above. There are several advantages and disadvantages of this technique relative to flame AAS which dictate the sample types for which it is amenable.

An inherent sensitivity 10 to 50 times greater than flame atomic absorption and very small sample requirements (usually 20 ml) are the major advantages. It therefore finds application for samples requiring low detection limits with limited sample volume. These conditions often exist for precipitation samples.

5.2.4 Cumulative Air Sampling Network

The same analysis procedures as section 5.2.2. (Event Air Sampling) apply for the nylon and Whatman 41 filters in the cumulative air sampling network.

The W40 filters are analyses for both water quality and inoganic trace constituents. A 20 minute ultrasonic bath in 50 ml distilled deionized water is followed by oven digestion in 5% HNO_3. The extact is then split. One aliquot is analysed for Zn, Fe, Ni, Cu, Pb, Al, Cd, Mn, and V by Atomic Absorption Graphite Furance. The second aliquot is analysed for $SO_4^=$, $N\text{-}NO_3^-$, and Cl^- by Ion Chromatography; Ca^{++} and Mg^{++} is analyzed by Inductively Coupled Plasma; Na^+ and K^+ is analyzed by Atomic Absorption Spectrophotometry; and $N\text{-}NH^+_4$ is analyzed by automated Phenate-hypochlorite Colorimetry.

5.3 Laboratory Quality Control/Quality Assurance Procedures:

The following is a brief description of the quality control procedures employed by the laboratory. Further details are available in the Quality Assurance Manual (1) or from documentation (4) available from the laboratory.

5.3.1 Water Quality Section

Three concentration levels of quality control standards are run along with the regular stock standards to insure the accuracy of the concentration plots. These quality control standards are made up independently from regular "standard stock".

In-run standards are analysed at sequential intervals throughout the day's run, usually about every ten samples. This provides a check for instrument sensitivity fluctuation during the course of a day.

Duplicate analysis is employed to determine standard deviation criteria for the particular analytical method. For more detailed QA procedures, refer to the water quality section in the 1981 Annual Quality Control Report (5).

5.3.2 Inorganic Trace Contaminants

Inductively Coupled Argon Plasma (ICP):

Two standards (.06 mg/L - i.e., 0.003 x 20 and 0.20 mg/L - i.e., .010 x 20) are carried through the concentration procedures and analyzed. Two filtered composites of cumulative samples are concentrated 20 times and analyzed. One composite is spiked at higher levels. The standard and composite concentrations must be within $\pm$ 3 standard deviations of the mean values calculated from the previous analysis, otherwise samples are checked by GFAAS.

Precision is calculated from the standard deviation of the difference between 3 duplicates per run at various concentration levels.

GFAAS and Flame AAS:

After the analysis of the calibration standards three "check" standards are analyzed. As well, two E.P.A. (Environmental Protection Agency) solutions are analyzed, one with a concentration level at the low end of the calibration curve

and the other at the higher level. E.P.A. concentrations must be within $\pm$ 3 standard deviations of the certified values.

Precision is calculated from the standard deviation of two quality control E.P.A. solutions which are analyzed with each set of standards.

6.0 Data Management

The following sections will briefly describe the management of data in the APIOS networks. The data handling flow chart diagram in Figure 25 illustrates the procedures which are followed to store and validate all data generated in the program. The merging and editing of field and laboratory data from the Laboratory Information System (L.I.S.) to the Sample Information System (S.I.S.) is illustrated in Figure 26. Similarly, the data validation procedures flow chart is illustrated in Figure 27. Both the L.I.S. and S.I.S. will be briefly described in the following section. For detailed information about the S.I.S. and L.I.S. refer to the "Sample Information System - User Manual" (6) published by the Systems Development Section, Finance and Administration Division.

6.1 Database Design

All samples and field submission sheets are shipped to the central laboratory located on Resources Road in Toronto. Samples are received and prepared for analysis according to Section 5.1 "Sample Reception and Preparation". At this point, the samples are logged into the L.I.S. system and analysed. Results are temporarily stored in the L.I.S. database. The field submission sheets are screened and are entered in the S.I.S. database when the analysis of the sample has been completed. The L.I.S. data are then deposited and merged into the S.I.S. database with the corresponding field information. The data can then be screened, validated, and reported.

The L.I.S. processing begins with the log-in of samples from the sample reception area. Samples are given a laboratory sample number and submission information is then entered into the system. The system is capable of keeping track of the samples as they move through work stations in the laboratory by using microcomputers located in all work stations. The system will select the samples to be batched according to priority and time of receipt. The selection of batches and the generation of bench sheets listing samples to be analysed at work stations is one of the analyst's functions. The evaluation and approval of interim results from individual work stations is based on the interactive dialogue between the system and the senior analyst. When all the tests requested in a sample submission have been completed, a final analytical result report is printed and distributed.

Usually on a weekly basis, a computer tape is produced at the laboratory which contains all the analyses performed at that point. The tape is used to update the S.I.S. master file. There are two types of records in this file, interim and final. An interim report has the same format as a final report except that all the analyses for a sample have not been completed at the time of data transfer to the S.I.S. When the data tape is finally updated, a report is sent to the database manager. Field data can then be merged into this file and later screened and validated.

6.2 Data Screening and Validation

Data validation and screening techniques have been established to evaluate all data collected in the networks before any reporting or data analysis is made. Data validation consists of various screening techniques, checks, and statistical routines which are applied to identify unusual or suspect data. These suspect data are then thoroughly scrutinized so that a decision can be made whether to include these data into the database.

Field data are screened using manual and computer techniques. Field submission sheets are visually checked for missing information, incorrect dates, incorrect times, and illogical coding to ensure that field data has been properly entered prior to keypunching into the S.I.S. After keypunching, all the field information is then screened using computer programs to re-check that the sampling dates are correct and that the coding of samples has been properly keypunched.

Sample records are qualified by two methods. Office comment codes are appended to sample records to indicate failure of specific integrity tests or sample representativeness. Secondly, if outliers are detected or gross limit checks fail, validation flags may be appended to individual analytical results.

6.2.1 Precipitation Samples

Precipitation samples from both networks are validated utilizing three separate approaches, each of which is described below.

1. Sample Analysis Integrity Checks

The first approach applied to data validation is to check the integrity of sample analysis to determine completeness of analysis and to determine possible inaccurate analytical results. Integrity checks include ionic balance, theoretical vs. observed conductance, theoretical vs. observed pH, total hydrogen vs. free hydrogen, and observed field pH vs. observed lab pH. Sample representativeness is determined by calculating sampler collection efficiency.

Ionic Balance:

anion equivalence =

$$\frac{(SO_4^{=}) \times 2}{96.1} + \frac{(NO_3^{-}\text{-}N)}{14} + \frac{(Cl^{-})}{35.5} + 0.001\underbrace{\left[\frac{4.90}{10^{-pH} + 6}\right]}_{\text{bicarbonate correction}}$$

cation equivalence =

$$10^{-pH} + 3 + \frac{(NH_4^{+}\text{-}N)}{14} + \frac{(K^{+})}{39.1} + \frac{(Ca^{++}) \times 2}{40.1} + \frac{(Mg^{++}) \times 2}{24.3} + \frac{(Na^{+})}{23}$$

$$\% \text{ Discrepancy} = \frac{(\text{anion equivalence} - \text{cation equivalence})}{(\text{anion equivalence} + \text{cation equivalence})} \times 200\ \%$$

The limits of % dicrepancy are based upon cumulative distributions compiled from historical data. The limits utilized were determined as the approximate 2.5 and 97.5 percentiles. All concentrations are in mg/l. Violation of these limits results in the office comment code "M" being appended to the record.

Theoretical vs. Observed Conductance Balance:

Conductivity (umho cm^{-1}) at 25^{o} per mg l^{-1}:

Ca^{++} - 2.60[a]	$SO_4^{=}$ - 1.54[a]
Cl^{-} - 2.14[a]	NH_4^{+}-N - 5.32[b]
Mg^{++} - 3.82[a]	NO_3^{-}-N - 5.09[a]
K^{+} - 1.84[a]	H^{+} - 350[b]
Na^{+} - 2.13[a]	

---

a - from "Standard Methods for the Examination of Water and Wastewater" 14th Edition, 1975.

b - calculated from equivalent conductance - CRC Handbook of Chemistry and Physics.

Theoretical Conductance =

$$10^{-pH+3} \times 350 + (SO_4^{=}) \times 1.54 + (NO_3^{-} - N) \times 5.09 + (Cl^{-}) \times 2.14 + (NH_4^{+} - N) \times 5.32 + (K^{+}) \times 1.84 + (Ca^{++}) \times 2.60 + (Na^{+}) \times 2.13 + (Mg^{++}) \times 3.82$$

$$\% \text{ Discrepancy} = \frac{(\text{Observed Conductance} - \text{Theoretical Conductance})}{(\text{Observed Conductance} + \text{Theoretical Conductance})} \times 200\ \%$$

The upper and lower limits are based upon historical cumulative frequency distributions. The upper and lower limits approximate the 97.5 and 2.5 percentiles respectively. All concentrations are in mg l^{-1}. Violation of these limits results in the office comment code "C" being appended to the record.

Theorectical pH vs. Observed pH:

As discussed by Stensland (1978), rain or melted snow maintains charge balance and if it is assumed that falling raindrops are in equilibrium with atmospheric carbon dioxide ($P_xCO_2 = 320 \times 10^{-6}$ atm) then the following equation can be proposed for the calculation of theoretical pH.

$$\text{Theorectical pH} = 6 - \log_{10} (((\text{Net Ions}) + ((\text{Net Ions})^2 + (4K_H K_1 PCO_2))^{0.5})/2)$$

$$\text{Net Ions} = (SO_4^{=}) + (NO_3^{-}) + (Cl^{-}) - (Ca^{++}) - (Mg^{++}) - (NH_4^{+}) - (Na^{+}) - (K^{+})$$

$K_H = 0.034 \times 10^{6}$ ueq/l/atm

$K_1 = 4.5 \times 10^{-1}$ ueq/l

$P_xCO_2 = 320 \times 10^{-6}$ atm

$$\% \text{ Discrepancy} = \frac{(\text{Observed Lab pH} - \text{Theoretical Lab pH})}{(\text{Observed Lab pH} + \text{Theoretical Lab pH})} \times 200\ \%$$

All concentrations are in ueq/l.

The upper and lower limits are based upon the cumulative frequency distribution compiled from historical data. The upper and lower limits approximate the 2.5 and 97.5 percentile respectively. All concentrations are in mg l^{-1}. Violation of these limits results in the office comment code "H" being appended to the record.

Free Hydrogen vs. Total Hydrogen:

$$\text{Free } (H^+) = 10^{-pH+3} = \text{mg } H^+ l^{-1}$$
$$\text{Total } (H^+) = \text{Total Acidity}/50 = \text{mg } H^+ l^{-1}$$

$$\text{Ratio} = \frac{\text{Free } (H^+)}{\text{Total } (H^+)} = \frac{10^{-pH+3} \times 50}{\text{Total Acidity}}$$

Total acidity results determined by Gran titration will be checked using a similar comparison as shown above.

Observed Field pH vs. Observed Lab pH (event samples only):

$$\% \text{ Discrepancy} = \frac{(\text{Observed Lab pH} - \text{Observed Field pH}) \times 200\ \%}{(\text{Observed Lab pH} + \text{Observed Field pH})}$$

The determined upper and lower limits are based upon historical cumulative frequency distributions. The upper and lower limit approximate the 97.5 and 2.5 percentiles respectively. A percentage discrepancy which exceeds the upper limit may suggest possible contamination (and neutralization) of the sample by windblown soil or other debris. A percentage discrepancy which exceeds the lower limit would indicate further investigation into the validity of the reported "Field pH" and "Lab pH". Violation of these limits result in the inclusion of the office comment code "J".

Sample Representativeness - Collection Efficiency:

Calculation of Equivalent Precipitation Depth (mm)

M.I.C. Type "A" Instrumentation:

$$\text{Equivalent Precipitation Depth (mm)} = \frac{\text{Volume Collected (ml)} \times 3.8}{100}$$

Aerochem Metrics Instrumentation:

$$\text{Equivalent Precipitation Depth (mm)} = \frac{\text{Volume Collected (ml)}}{1000} \times 15.6$$

$$\%\ \text{Efficiency} = \frac{\text{Equivalent Precipitation Depth (mm)}}{\text{Gauge Depth (mm)}} \times 100\ \%$$

The upper and lower limits for collection efficiency are determined subjectively to be 120.0% and 50.0% respectively. Reported collection efficiencies less than 50.0% may indicate missed events due to instrument malfunction or may indicate loss of sample volume due to evaporation. Collection efficiencies which exceed 120% may indicate invalid "Gauge Depth" values. Violation of the above limits result in the incorporation of the office comment code "N" into the database. The reported "Gauge Depth" represents the measured precipitation depth from a standard rain gauge or a Nipher-shielded snow gauge.

2. Gross Limit Checks

The second approach is to apply gross limit checks to identify unlikely values. Lower limits are generally defined as detection limits and upper limits are determined from cumulative frequency distributions based on historical data. If a gross limit check is violated, a report is generated and the sample investigated further. The approximate 97.5 percentile is utilized for the upper limit and the 2.5 percentile or "detection limit" is utilized as the lower limit.

3. Statistical Check for Outliers

The third approach is to screen the data for outliers statistically by applying the Dixon Ratio test to the highest and lowest values observed in each sample cluster or region on a daily or 28-day basis. Outliers were determined at the 95% level of confidence. If an outlier is detected the sample is investigated further.

6.3 Data Reporting

Data generated from the monitoring networks are validated and reported on a yearly basis. Hard copy reports are generated and are supplemented with station descriptions and map locations (UTM co-ordinates), as well as comment code indexes and any other relevant information. Data can also be reported to a user on a data tape supplemented by a data file format description. Any questions regarding the reporting of data should be directed to the APIOS Atmospheric Deposition and Chemistry Program Leader, Dr. Neville Reid at (416) 965-1634.

Examples of the format used in reporting the data are presented in Figures 28 to 31. Station identification codes are given in Table 3.

7.0 DOCUMENT CONTROL

To maintain up-to-date documents and operating procedures, this manual will use a standardized indexing format along with provisions for easy placement of pages or sections that are changed or updated. The following format will be used:

Section No:

Revision No:

Date (of revision):

Page:

A distribution record will be established to allow revisions to be distributed to all users. To enter a name into this record system, fill out the "Distribution Record Sheet" on the next page and mail to the address shown.

Distribution Record Sheet

Document: APIOS Technical and Operating Manual

Date: _____

Name and Address of User: _____

_____

_____

_____

_____

_____

_____

Mail to: Ontario Ministry of the Environment
Air Resources Branch
880 Bay Street, 4th Floor
Toronto, Ontario, M5S 1Z8, Canada
Attention: W. S. Bardswick

REFERENCES

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12. Kirk, R.W., 1982: "Data Validation Procedures - Daily Precipitation Monitoring Network 1980/81", Ontario Ministry of the Environment, Air Resources Branch, December 1982.

13. Kirk, R.W., 1983: "Data Validation Procedures - Cumulative Precipitation Monitoring Network", Ontario Ministry of the Environment, Air Resources Branch, May 1983.

APPENDICES

Figure 1

APIOS Event Wet/Dry Deposition Network Station Locations

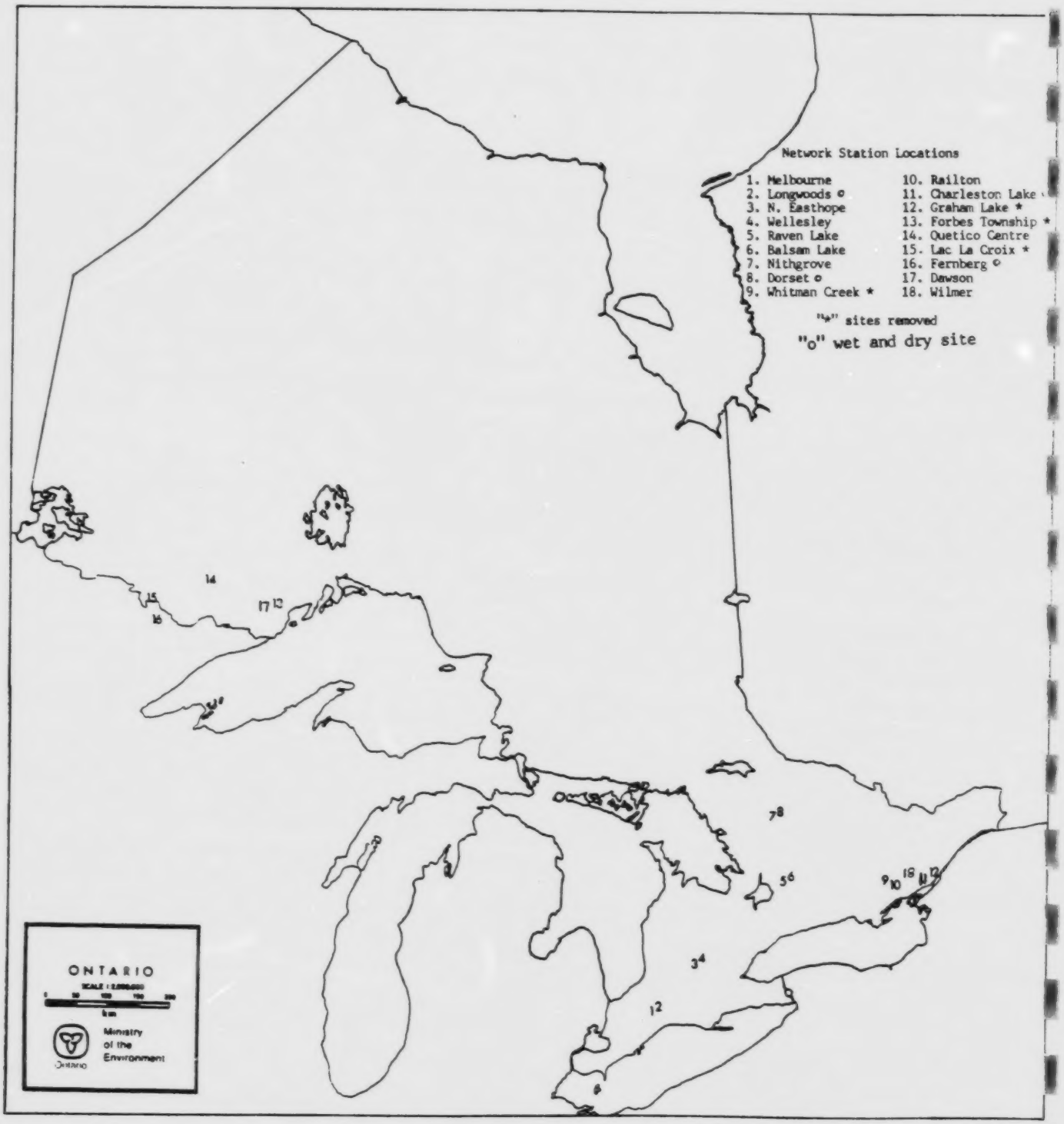
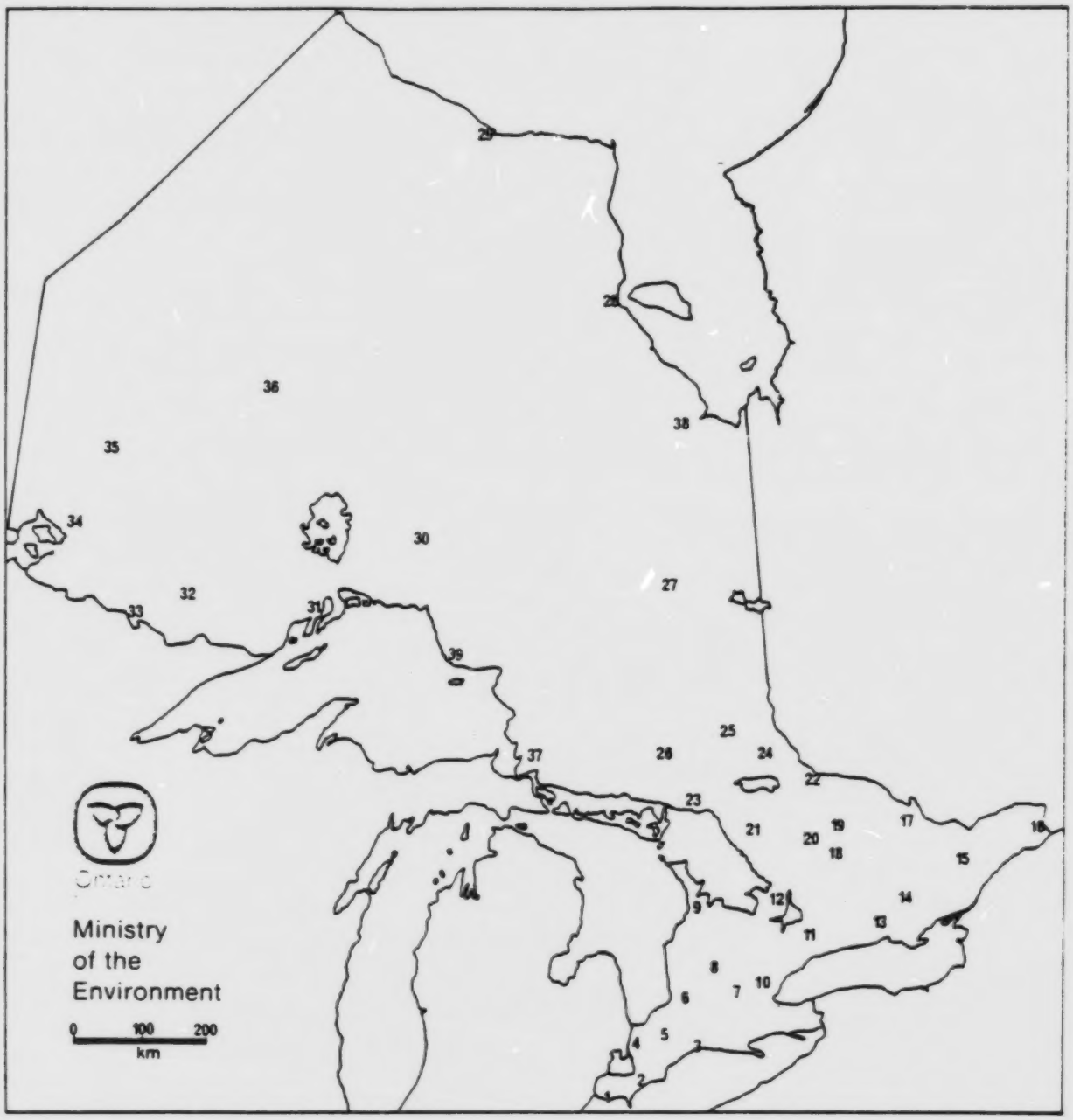


FIGURE 2.

LOCATION OF APIOS CUMULATIVE WET/DRY DEPOSITION NETWORK SITES



1. Colchester*
2. Merlin
3. Pt. Stanley*
4. Wilkesport*
5. Alvinston
6. Huron Park
7. Waterloo
8. Palmerston*
9. Shallow Lake*
10. Milton (removed March 1984)
11. Uxbridge*
12. Coldwater
13. Campbellford*
14. Cloyne*
(replacing Kaladar, June 1983)
15. Smith's Falls*
16. Dalhousie Mills*
17. Golden Lake*
18. Wilberforce
19. Whitney
20. Dorset*
21. McKellar*
22. Mattawa*
23. Killarney*
24. Bear Island
25. Gowganda*
26. Azure Lake
(replacing Ramsey, June 1983)
27. Moonbeam*
28. Attawapiskat
(removed February 1984)
29. Winisk (removed Dec'86)
30. Geraldton*
(replacing Nakina, August 1983)
31. Dorion*
32. Quetico Centre*
33. Lac la Croix
34. Experimental Lakes Area
35. Ear Falls*
36. Pickle Lake*
37. Turkey Lake*
38. Moosonee*
(installed October, 1985)
39. Otter Island*
(operated only during "summer" periods)

* indicates both a dry and wet deposition network site

Fig.3 ORGANIZATIONAL CHART

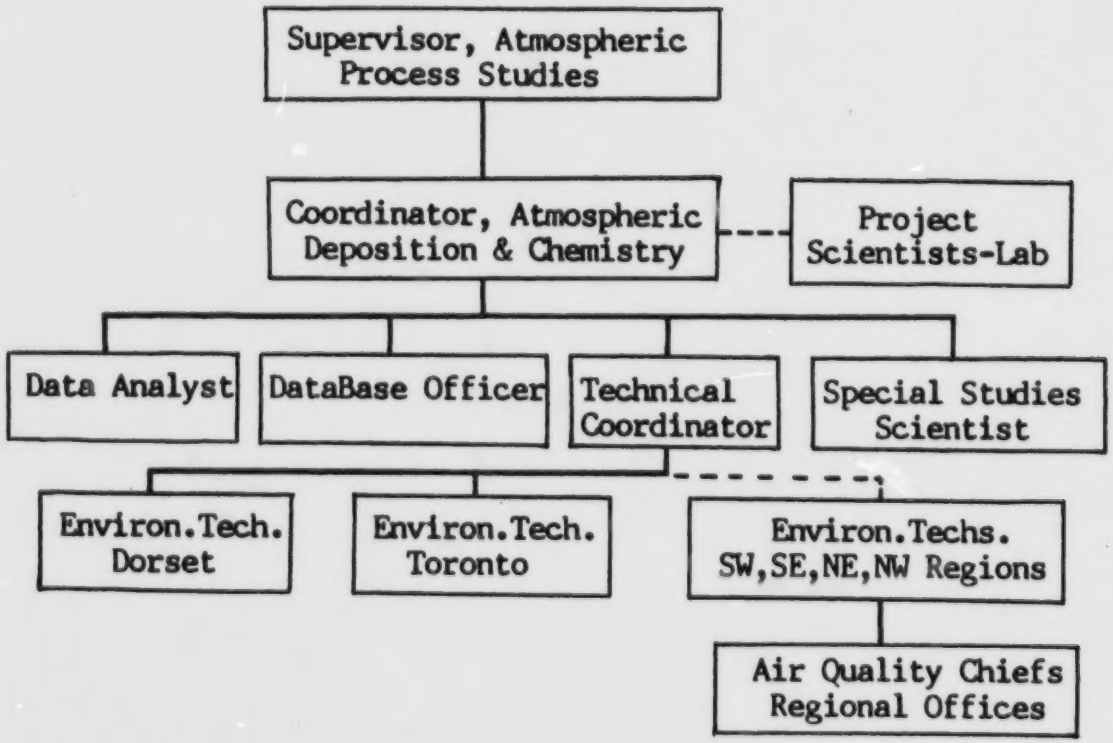


Fig. 4 APIOS SITE DESCRIPTION QUESTIONNAIRE

Date: _____ Type of Site

COMPLETED BY: _____ (check one)

REVISION NO: _____ __ Existing Site (regular network)

__ Potential Site

__ Special Study Site

1. SITE IDENTIFICATION

Cumulative Wet _____ Cumulative Dry _____

Event Wet _____ Event Dry _____

Other (describe) _____

Station Name _____ Station Number _____

MOE Region _____ County _____ Township _____

Latitude ____° ____' ____" Longitude ____° ____' ____" Elevation ____m

UTM Co-ordinates E N

Name of Primary Operator _____

Alternate Operator _____

Regional Technician _____

Mailing Address (Primary Operator)

_____

_____

_____

Phone (Primary Operator) _____/_____ (Res) ____/_____ (Bus)

Phone (Alternate Operator) _____/_____ (Res) ____/_____ (Bus)

Nearest APIOS Site Cumulative: Station Name _____

Distance _____ km

Event: Station Name _____

Distance _____ km

2. **LIST OF INSTRUMENTATION** (if applicable)

1) Instrument Type: _____

Cumulative Wet: _____ Cumulative Dry: _____

Event Wet: _____ Event Dry: _____

Other (describe): _____

Manufacturer: _____ Model #: _____

2) Instrument Type: _____

Cumulative Wet: _____ Cumulative Dry: _____

Event Wet: _____ Event Dry: _____

Other (describe): _____

Manufacturer: _____ Model #: _____

3) Instrument Type: _____

Cumulative Wet: _____ Cumulative Dry: _____

Event Wet: _____ Event Dry: _____

Other (describe): _____

Manufacturer: _____ Model #: _____

1) Standard Gauge Type _____

2) Standard Gauge Type _____

Other _____

_____

_____

_____

cont'd

3. SITE LOGISTICS

1) Is road access to site in summer: _____ good _____ fair _____ poor?

winter: _____ good _____ fair _____ poor?

2) Type of road surface? (dirt, gravel, oiled, paved) _____

3) How far is the primary collector from road access? _____ m

4) If necessary, how close can a vehicle approach the collector? _____

5) If no road access to site, how is site reached? (plane, snowmobile) _____

6) What is the available electrical power at site? _____

Volts _____ Amps _____ No. of circuits _____

7) Is the circuit on a: Receptacle GFIC _____

Circuit Breaker GFIC _____

No GFIC _____

Battery _____

8) What is the distance from collector receptacle (or proposed site) to circuit panel?

_____m

9) What are the number of power failures per month? _____

per year? _____

10) Are there any other logistical problems which prevent the sampling site being easily approached or operated?

(locked gate, guard dog, flooding in spring?)

_____

_____

_____

4. TOPOGRAPHY AND LAND USE

1) Ground slope at site: _____ °

2) Ground cover within 15 m of sampler (grass, scrub, gravel, sand, soil)

_____

3) Soil type within 10 m of site (sand, topsoil, clay, rocky)

_____

Soil type within 500 m of site (sand, topsoil, clay, rocky)

_____

4) Land use % near site, within 1 km/10 km

% Cultivated _____/_____

% Orchard _____/_____

% Lawn _____/_____

% Pasture _____/_____

% Forest _____/_____

% Water _____/_____

% Other (describe) _____/_____

Type of Cultivated crop(s) _____

Forest types within 1 km of site _____

5) What types of windbreaks are within 200 m of primary sampler (buildings, trees, hills) _____

6) Indicate any windbreaks within 200 m of primary sampler (Mark what quadrants of the compass have a windbreak)

cont'd

7) Prevailing wind direction during event (according to Operator)

Winter _____ °

Summer _____ °

8) Comment on local topography (i.e. flat, hilly, river, basin, etc.)

_____

_____

_____

_____

_____

_____

9) Cultivated Land Use

Type of Crop	Type of Herbicide or Insecticide Used and when applied	Type of Fertilizers and when applied	Future Crops	Distance to Crops	Direction to Crops

10) Any planned land use in future? _____

_____

_____

11) In winter is there any evidence of drifting snow? _____

12) Tall objects near sampler:

i) Trees _____ (species) Max Height _____ m

Distance _____ m Direction _____ o

ii) Buildings _____ (type) Height _____ m

Use _____ Type of Heating _____ Distance _____ m

Direction _____ o

iii) Other (overhead wires, telephone poles, hedges)

A) Object _____ Height _____ m

Direction _____ o Distance _____ m

B) Object _____ Height _____ m

Direction _____ o Distance _____ m

C) Object _____ Height _____ m

Direction _____ o Distance _____ m

D) Object _____ Height _____ m

Direction _____ o Distance _____ m

Comments _____

_____

_____

_____

_____

_____

_____

5. HUMAN ACTIVITY

1) Large highways (expressways): Distance _____ (Km, m)

Route # _____ Direction from Sampler _____

2) Other paved roads: Distance _____ (Km, m)

Direction from sampler _____

traffic: Heavy _____, Medium _____, Light _____

3) Unpaved road: Distance _____ (Km, m)

Direction from sampler _____

traffic: Heavy _____, Medium _____, Light _____

Surface (dirt, gravel, oiled) _____

4) Parking lot: Distance _____ (Km, m)

Direction from sampler _____

Unpaved _____ Surface material _____ Use: Continuous _____

5) Lake/river or rail traffic: Distance _____ (Km, m)

Direction from sampler _____ barge _____

lake steamer _____ rail _____

traffic: Heavy _____, Medium _____, Light _____

6) Snow clearing procedures:

Type of surface (road, parking log, hwy, walkway)	Surface distance from sampler	Direction from sampler	Snow Control (plowed, sanded, blown, salted-with what?)

7) Airport(s): Distance _____ (Km, m)

Direction from sampler _____ Name _____

traffic: Heavy _____, Medium _____, Light _____

traffic type: _____

8) Stationary sources:

Power plant(s): Distance _____ (Km, m)

Direction from sampler _____ Fuel (gas, coal) _____

Electrical Capacity _____ (KW_e, MW_e)

Light industry: Name _____ Distance _____ (km)

Direction from sampler _____ Product _____

Heavy industry: Name _____ Distance _____ (km)

Direction from sampler _____ Product _____

9) Other sources: Significant agricultural operations:

Distance _____ (Km, m)

Direction from sampler _____

Other (please describe) _____

_____

Distance _____ (Km, m)

Direction from sampler _____

Other could include - gravel pits, sewage lagoons, marshes, MTC,

Salt or Sand piles - (see Topographical Maps)

10) Effects from local cities, towns, or villages (population)

A	100,000
B	10,000
C	5,000
D	1,000

NAME	POPULATION (letter code)	DISTANCE	DIRECTION	TYPES OF POLLUTION SOURCES

6. SITE SUMMARY

List deviations from site criteria and all advantages and disadvantages of this site.

(use reverse side if necessary)

7. SITE LOCATION

1) A topographic map (Scale 1:50,000) indicating sample site with a Red X.

   - arrows on top map indicating best approach from nearest "MAIN" Highway.
   - indicate with red dots any major sources of pollution of contamination (industry, gravel pits, towns)

2) A concise description on how to reach this site. (below)

8. SITE DIAGRAM

1) Notable Items (mark all distances)

1. North
2. Direction of prevailing winds
3. Windbreaks
4. Roads (with names)
5. Parking lots
6. Buildings (indicate type of heating)
7. Potential contamination sources
8. Ground cover (grass, scrub, soil, sand)
9. Trees/hedges/marshes
10. Obstructions (include height): poles, towers
11. Topography
12. Water
13. Crops/gardens
14. Paths (foot, snowmobile, ski)
15. Location of existing hydro facilities
16. Position of sampler(s)
17. Nature of soil (rocky, sandy, clay)

2) Legend

Coniferous trees (include height, H=)

Deciduous trees (include height, H=)

Wooden fencing (include height, H=)

Wire fencing (include height, H=)

Grass

Direction of ground slope

Bushes/hedges (include height, H=)

Buildings (height and heating)

Railway tracks

9. **SITE PICTURES** (Indicates site name, compass point and date of photograph on back of all slides)

1) Two pictures are to be taken so as to best include all sampling instrumentation on site. If possible take pictures 90° apart from each other. Indicate on Site Diagram as P1 and P2 where the pictures were taken from. Also, identify each picture on a list of photographs.

2) Take four pictures showing the area surrounding the site. These should be taken at four compass points from just behind primary sampler facing in the direction of the compass point.

3) Special pictures showing nearby potential sources of contamination (e.g. salt pile) that may affect the site are to be taken. These should be indicated, if possible, on a site diagram as SP1, SP2, etc. with a description of the picture on the back of the print.

LIST OF PHOTOGRAPHS

#	Direction Facing	Comments

6AR14-Fig.25

Fig.5

Ministry of the Environment
Ontario

OPERATOR SAMPLE RECORD SHEET - EVENT NETWORK

1. Station Name:_____ 2. Sample Collected By:_____

Sampling Information

3. Type of Instrument:
_____ Aerochem Metric
_____ Co-located Aerochem Metric
_____ M.I.C. Type A1
_____ SES Sampler
_____ Other (Specify):_____

4. Sampling Start: Date Bag Inserted ____/____/____

Date Day/Month/Year	Time 0000-2400 hr.	Was it raining or snowing during the sample bag insertion?
___/___/___	_____	_____Yes _____No

5. Sampling End:

Date Day/Month/Year	Time 0000-2400 hr	Was it raining or snowing during the sample bag removal?
___/___/___	_____	_____Yes _____No

6. Type of Sample Collected:

Regular	Quality Assurance	Anything Else in Sample? (check as necessary.
_____Rain	_____Field Blank	_____Insects
_____Snow	_____Duplicates	_____Leaves
_____Mixture	_____Composite	_____Particles
_____Trace	_____Other (specify)	_____Fibres
		_____Other (Specify)

7. Regular Sample Only:

Start of Most Predominant Event: 0000-24000 hr _____

End of Most Predominant Event: 0000-2400 _____

Secondary Event Times From:_____ To:_____

Excess Volume (ml)_____

Intensity of Predominant Event
_____light
_____medium
_____heavy

8. Gauge Measurements:

Standard Rain Gauge Depth _____mm
Nipher Gauge Depth _____mm
Other Gauge Depth _____mm_____(specify type)

9. Instrumentation Problems:

	Date Day/Month/Year	Time 0000-2400	
Sampler Malfunctioned From:	__ ___ __	_____	
To:	__ ___ __	_____	
Events Missed:	___Yes ___No	If "Yes"	How Many?_____ When?_____

Sample Spilled or Leaked?_____Yes _____No.
Describe Malfunction:_____

10. Supplies (check if needed)

_____Bags	_____Gloves	_____Bottles
_____Operator Sheets	_____Distilled Water	_____Kimwipes
_____Log Book	_____Ethanol	_____Other (Specify)
_____Cable Ties		

0437 8/83

Fig.6 EVENT PRECIPITATION COLLECTOR

YEAR _____

STATION _____ LOCATION _____

TYPE _____ SERIAL # _____

DATE						
INITIALS						
P.C.BOARD (min:secs)						
SENSOR GRIDS (new)						
HOOD GASKET (new)						
POWER & WIRING						
MOTOR BOX						
OUTPUT (amps)						
SWITCHES (new)						
NIPHER GAUGE OK						
BAG PLACEMENT						

REPAIRS/CALIBRATIONS/COMMENTS :

Fig.7 AIR SAMPLER

YEAR _____

STATION _____ LOCATION _____

TYPE _____ SERIAL # _____

DATE						
INITIALS						
FLOWRATE (lpm)						
VACUUM (inches)						
VOLUME COUNTERS						
TIME COUNTERS / CLOCK						
PUMP (serial #_____)						
DIAPHRAGM						
VALVES						
FLAPS						
VACUSHIELD (new)						
SEQUENCING OK						
TYGON TUBING (new)						
CALIBRATION (+/-)						
MASS FLOWMETER (ser #)						

REPAIRS/CALIBRATIONS/COMMENTS :

Fig.8 CUMULATIVE PRECIPITATION COLLECTOR

YEAR _____

STATION _____ LOCATION _____

TYPE _____ SERIAL # _____

DATE						
INITIALS						
LIMIT SWITCHES (new)						
LIMIT SCREW ADJUST.						
CHAIN TENSION						
CLUTCH ADJUSTMENT						
SPROCKETS ALIGNMENT						
EXPAN.PINS / SET SCREW						
MOTOR (ser.#_____)						
HOOD GASKET (new)						
POWER & WIRING						
P.C.BOARD (min:sec)						
P.C.BOARD (ser.#_____)						
NIPHER GAUGE DEPTH OK						
SENSOR GRIDS (new)						
G.F.I.C TEST						

REPAIRS/CALIBRATIONS/COMMENTS :

Fig.9 PRECIPITATION GAUGE

YEAR _____

STATION # _____ LOCATION _____

TYPE _____ SERIAL # _____

DATE						
INITIALS						
PUNCH MECHANISM						
ALIGNMENT						
TIME						
PINS						
MEASURING MECHANISM						
TAPE (AMOUNT)						
BATTERY(VOLTS)						

REPAIRS COMMENTS:

Figure 10: SUPPLIES REQUISITION FORM

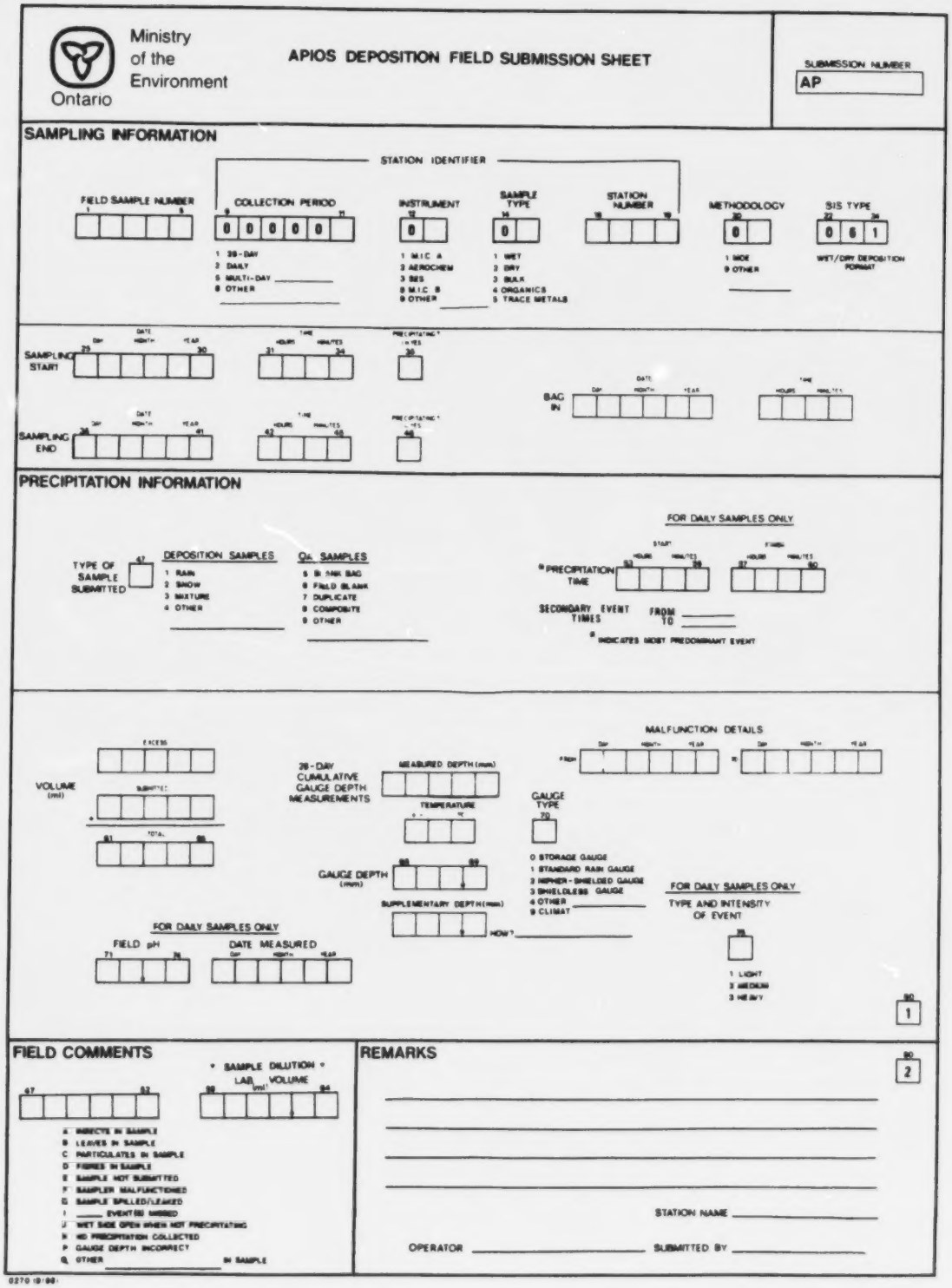
6 Month Request

Region: _____
Name: _____
Date: _____

ITEM		# REQUIRED (SPECIFY EXACTLY)	
Ethanol		_____	bottles
Methanol		_____	bottles
Methanol (gauges)		_____	cans (5 g)
Ethylene Glycol		_____	cans (5 g)
Gloves		_____	boxes
Kimwipes		_____	boxes
Tape - Duct		_____	rolls
- Clear		_____	rolls
Whirl-Pak Bags	- 18 oz	_____	boxes
	- 6 oz	_____	boxes
Zip Lock Bags		_____	boxes
P.C. Boards	- MIC Type A	_____	
	- MIC Type B	_____	
	- Aerochem	_____	
Sensor Grids	- Type A (pin)	_____	pair
	- Type A or B (screw)	_____	pair
	- Aerochem	_____	pair
Limit Switches	- Type A (old)	_____	
	- Type A (new)	_____	
	- Type B	_____	
	- Aerochem N/O	_____	
	N/C	_____	
Thermometers		_____	
Tweezers (teflon-coated)		_____	pair
Event Bottles		_____	boxes
APIOS Lables		_____	sheets
Hood Gaskets	- MIC	_____	
	- Aerochem	_____	
Bags	- MIC Short	_____	
	- MIC Long	_____	
	- Aerochem	_____	
Filters	- Teflon (47 mm)	_____	
	- Teflon Pallflex (8x10)	_____	
	- Nylon	_____	
	- W40	_____	
	- W41 (8x10)	_____	
	- W41 (impregnated)	_____	
	- Glass Fibre Soxhlet (47 mm)	_____	
	- Nucleopore Polycarbonate (8 um)	_____	
Field Sheets	- Precipitation	_____	pads/50
	- Air Sampling	_____	pads/50
	- Toxics	_____	pads/50
Operator Sheets	- Daily	_____	pads/50
	- Cumulative	_____	pads/50
Log Book Forms (Specify type)		_____	
Cable Ties		_____	
Sampling Pumps	- Sequential	_____	
	- Lovol DC	_____	
	- Lovol AC	_____	
Repair Kits	- Sequential	_____	
(flaps, gasket)	- Lovol DC	_____	
	- Lovol AC	_____	
Diaphragms	- K309	_____	
	- K294	_____	
Brushes	- Small (New long pump)	_____	
	- Large	_____	
"O" Rings	- Baseplate	_____	
	- Adapter	_____	
	- Filter pack (top, middle inner or middle outer)	_____	
Vacushields		_____	boxes/3 box
Counters	- Volume (Specify AC or DC)	_____	
	- Time (Specify AC or DC)	_____	
Tubing	- Tygon - (Specify length)	_____	feet
	- Teflon (Spaghetti)	_____	feet
Stationary (specify)		_____	
		_____	
		_____	
Other (specify)		_____	
		_____	
		_____	

A1876

Fig.11 Deposition Field Submission Sheet



Ministry of the Environment
Ontario

APIOS DEPOSITION FIELD SUBMISSION SHEET

SUBMISSION NUMBER
AP

SAMPLING INFORMATION

STATION IDENTIFIER

FIELD SAMPLE NUMBER (1–5)

COLLECTION PERIOD (6–11)
0 0 0 0 0
1 28-DAY
2 DAILY
5 MULTI-DAY _____
8 OTHER _____

INSTRUMENT (12–13)
0
1 M.I.C. A
2 AEROCHEM
3 BES
8 M.I.C. B
9 OTHER _____

SAMPLE TYPE (14–15)
0
1 WET
2 DRY
3 BULK
4 ORGANICS
5 TRACE METALS

STATION NUMBER (16–19)

METHODOLOGY (20–21)
0
1 WDE
9 OTHER _____

SIS TYPE (22–24)
0 6 1
WET/DRY DEPOSITION FORMAT

SAMPLING START — DATE: DAY (25–26) MONTH (27–28) YEAR (29–30); TIME: HOURS (31–32) MINUTES (33–34); PRECIPITATING? YES (35)

SAMPLING END — DATE: DAY (36–37) MONTH (38–39) YEAR (40–41); TIME: HOURS (42–43) MINUTES (44–45); PRECIPITATING? YES (46)

BAG IN — DATE: DAY MONTH YEAR; TIME: HOURS MINUTES

PRECIPITATION INFORMATION

TYPE OF SAMPLE SUBMITTED (47)

DEPOSITION SAMPLES
1 RAIN
2 SNOW
3 MIXTURE
4 OTHER _____

QA SAMPLES
5 BLANK BAG
6 FIELD BLANK
7 DUPLICATE
8 COMPOSITE
9 OTHER _____

FOR DAILY SAMPLES ONLY

*PRECIPITATION TIME — START: HOURS (52–53) MINUTES (54–55); FINISH: HOURS (57–58) MINUTES (59–60)

SECONDARY EVENT TIMES — FROM _____ TO _____

* INDICATES MOST PREDOMINANT EVENT

VOLUME (ml) — EXCESS; SUBMITTED; TOTAL (61–66)

28-DAY CUMULATIVE GAUGE DEPTH MEASUREMENTS — MEASURED DEPTH (mm); TEMPERATURE (°C)

GAUGE DEPTH (mm) (89–92)

SUPPLEMENTARY DEPTH (mm) _____ HOW? _____

GAUGE TYPE (70)
0 STORAGE GAUGE
1 STANDARD RAIN GAUGE
2 NIPHER-SHIELDED GAUGE
3 SHIELDLESS GAUGE
4 OTHER _____
9 CLIMAT

MALFUNCTION DETAILS — FROM: DAY MONTH YEAR; TO: DAY MONTH YEAR

FOR DAILY SAMPLES ONLY

FIELD pH (71–76)

DATE MEASURED: DAY MONTH YEAR

FOR DAILY SAMPLES ONLY

TYPE AND INTENSITY OF EVENT (78)
1 LIGHT
2 MEDIUM
3 HEAVY

80 1

FIELD COMMENTS

* SAMPLE DILUTION *
LAB VOLUME (ml) (83–84)

(47–52)

A INSECTS IN SAMPLE
B LEAVES IN SAMPLE
C PARTICULATES IN SAMPLE
D FECES IN SAMPLE
E SAMPLE NOT SUBMITTED
F SAMPLER MALFUNCTIONED
G SAMPLE SPILLED/LEAKED
I _____ EVENT(S) MISSED
J WET SIDE OPEN WHEN NOT PRECIPITATING
N NO PRECIPITATION COLLECTED
P GAUGE DEPTH INCORRECT
Q OTHER _____ IN SAMPLE

REMARKS

80 2

STATION NAME _____

OPERATOR _____ SUBMITTED BY _____

0270 (D/88)

Figure 12
Event Network Summary Sheet
Collection of Event Samples

Region:_____

Month:_____

Year:_____

SITE NAME

Day	Vol.	G.D.	Vol.	G.D.	Vol.	G.D.	Vol.	G.D.	Vol.	G.D.	Vol.	G.D.	Vol.	G.D.
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														

Codes:
0 - no volume collected but gauge depth taken
( ) - multiple day sample
— - no precipitation
S - spilled sample
T - trace sample

M - sampler malfunction
FB - field blank
D - duplicate
C - composite

AR 8-48

Fig.13 Air Sampling Field Submission Sheet

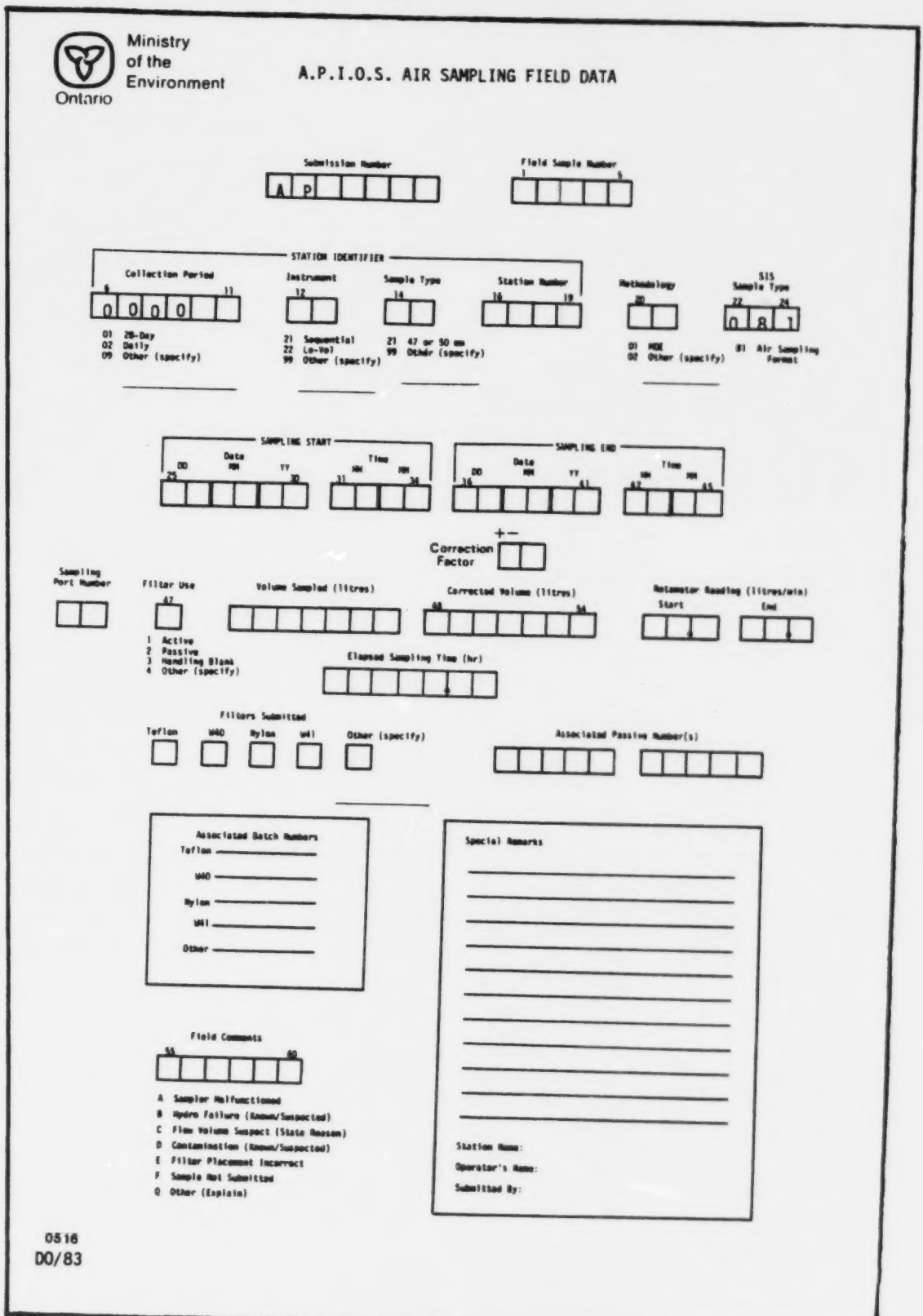


Fig.14

Ministry of the Environment
Ontario

OPERATOR SAMPLE RECORD SHEET - CUMULATIVE NETWORK

1. Station Name _____ 2. Sample Collected By: _____

Sampling Information

3. Type of Instruments
   - ___ Sangamo/M.L.C
   - ___ Lo-vol Air Sampler
   - ___ Other (specify): _____

4. Type of Samples Collected

	Co-located	For Wet Bag Only:
___ Wet Bag		___ Rain
___ Filterpack	___ Wet Bag	___ Snow
___ Composite	___ Filterpack	___ Mixture
___ Other (specify):		_____

5. Sampling Starts

Date Day/Month/Year	Time 0000-2400 hr	Was it raining or snowing during the sample changeover?
__ __ __	_____	___ Yes ___ No

6. Sampling Ends

Date Day/Month/Year	Time 0000-2400 hr	Was it raining or snowing during the sample changeover?	Composite Handling Date (If different from end date) Day/Month/Year	Time
__ __ __	_____	___ Yes ___ No	__ __ __	___

7. Precipitation Gauge Measurements
   - Storage Gauge, Observed Depth _____ cm
   - Nipher Gauge, Observed Depth (if applicable) _____ mm
   - Storage Gauge Solution Temperature _____ °C

8. Lo-vol Sampler Measurements (if applicable)
   - Volume sampled _____ litres
   - Elapsed sampling time _____ hours
   - Sampling flow rate on _____ litres/minute
   - Sampling flow rate off _____ litres/minute

   Was it necessary to adjust the flow rate during the sample period?
   ___ Yes ___ No
   If yes, when?
   Date _____ Time _____ Flow rate at time of adjustment _____ litres/minute
   Date _____ Time _____ Flow rate at time of adjustment _____ litres/minute

9. Factors Affecting the Samples Collected
   (check as many as necessary)

___ Sample Leaked	Filter Pack:	
___ Insects in sample	___ Filter Pack Dropped	
___ Leaves in sample	___ Loose Connection	
___ Particles in sample	___ Filters Wet	
___ Fibres in sample		
___ Other (bird droppings, hair, etc.) in sample (specify) _____		

   Other Factors
   - ___ Activity in the area (construction, harvesting, etc.) (specify) _____

10. Instrumentation Problems
    - ___ Precipitation Collector Malfunctioned
    - ___ Lo-Vol Air Sampler Malfunction

When did malfunction occur? (Day/Month/Year)	When did malfunction(s) occur? (Day/Month/Year)
From __ __ __ To __ __ __	From __ __ __ To __ __ __
From __ __ __ To __ __ __	From __ __ __ To __ __ __
Missed Events? ___ Yes ___ No	Describe malfunctions if known:
If "Yes", How many? _____ When? _____	_____ _____ _____

11. Supplies
    (check if needed)

___ Bags	___ Cable Ties	___ Kimwipes
___ Thermometer	___ Gloves	___ Whirlpak Bags
___ Operator Sheets	___ Distilled Water	___ Sensor Grids
___ Log Book	___ Ethanol	___ P. C. Boards

0436 8/83

Fig. 15. - - GUAGE RECORD SHEET

STATION: _____

Reading No.	Period Date: Day/Month/Year	Solution Depth (cm)	%Water (Sol'n Depth - Charge Depth / Sol'n Depth x 100)	Solution Temp. (°C)	Solution Density (kg/l) from Graph	Water Equivalent (cm) Sol'n Density x Sol'n Depth	Preci (cm)

Fig. 16 Gauge Density Graph

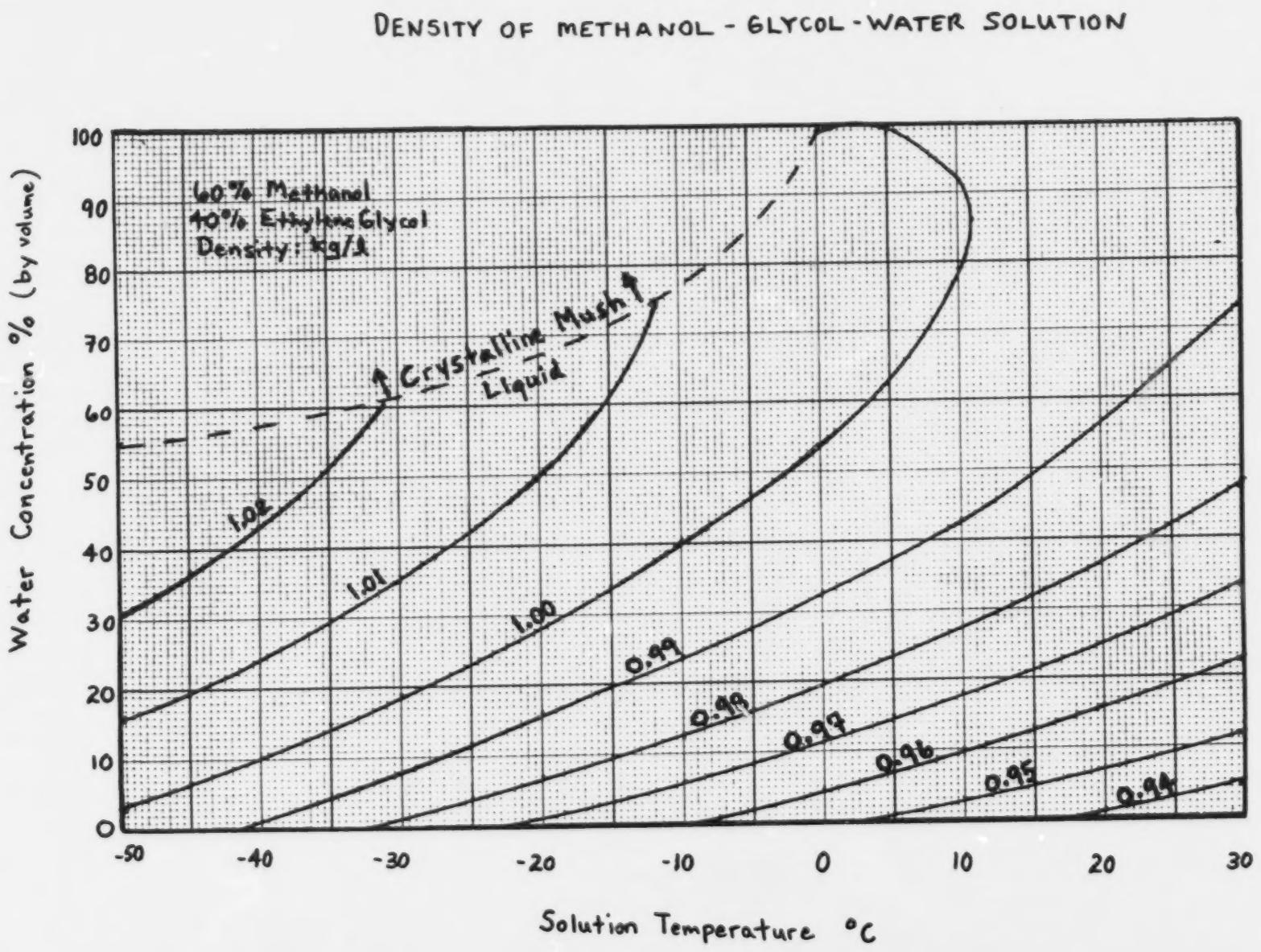


Figure No. 17

APIOS Air Sampler Calibration Sheet

Calibration Date: _____

Date of Last Calibration: _____ **% Error:** _____

Instrument Type: _____

Serial Number: _____

Station Number and Location: _____

Calibrator Name: _____

Weather Conditions: _____

Mass Flowmeter Serial Number: _____

Port Number: _____

Observed Flow Rate (l/min) Rotameter	Actual Flow Rate (l/min) Mass Flowmeter	Time (min.)	Observed Volume (l) Digital Readout	Calculated Volume (l) Mass Flowmeter
			Percentage Error: ± _____%	

Action Required:

Action Taken:

Figure No: 18

APIOS Precipitation Gauge Calibration Sheet

Calibration Date: _____

Date of Last Calibration: _____

Serial Number: _____

Station Number and Location: _____

Calibrator Name: _____

Weight Added (grams)	Actual Precip. Depth (inches)	Recorded Precip. Depth (inches)	% Difference

Action Required:

Action Taken:

Figure No: 19

APIOS Weighing Scale Calibration Sheet

Calibration Date: _____

Date of Last Calibration: _____

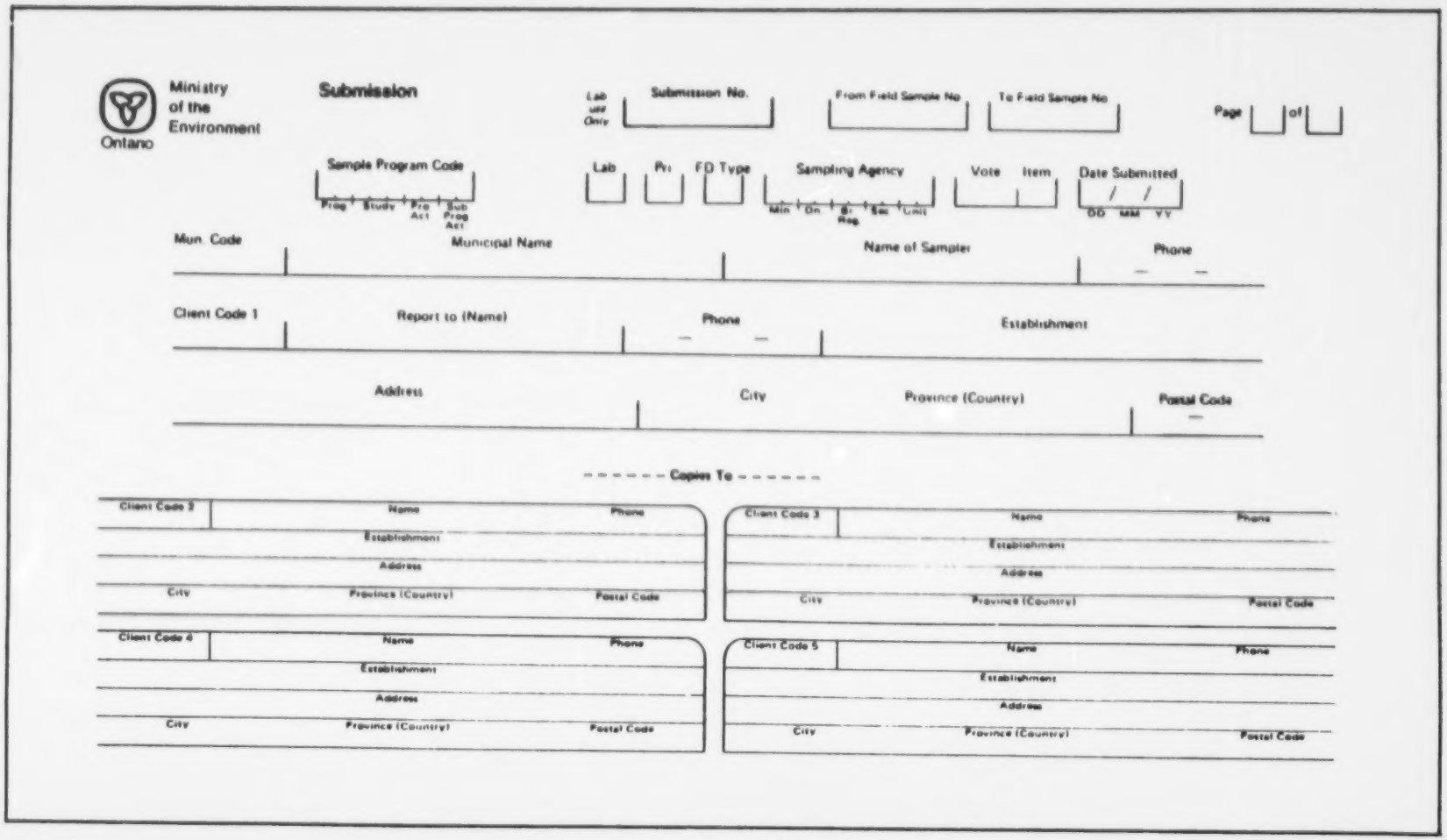
Serial Number: _____

Station Number and Location: _____

Calibrator Name: _____

Weight Added (grams)	Digital Readout (grams)	% Difference
Action Required:		
Action Taken:		

Fig. 20. Laboratory Submission Sheet



MOE 0951 3/80

Fig. 21. Request For Analysis Form

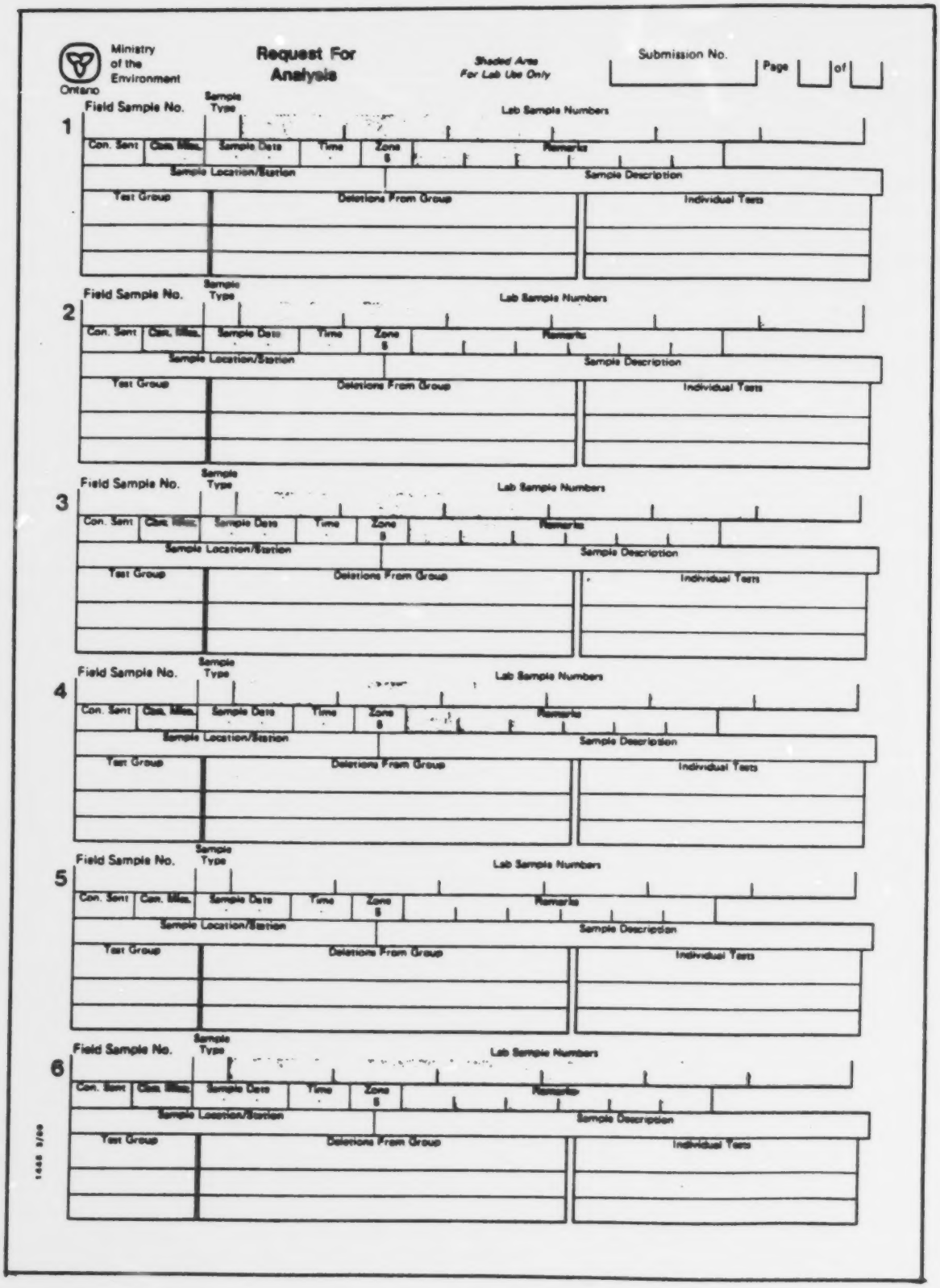


Figure 22. Laboratory Sample Handling

Event Precipitation Samples

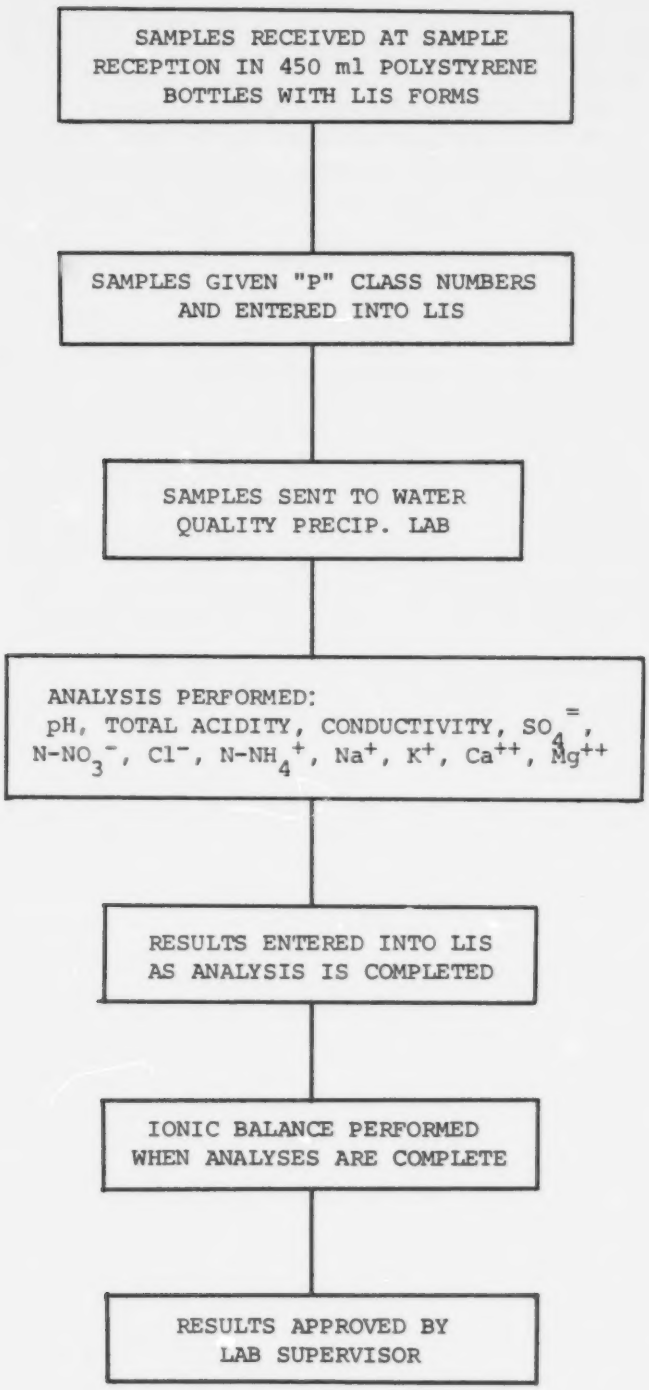

SAMPLES RECEIVED AT SAMPLE RECEPTION IN 450 ml POLYSTYRENE BOTTLES WITH LIS FORMS
SAMPLES GIVEN "P" CLASS NUMBERS AND ENTERED INTO LIS
SAMPLES SENT TO WATER QUALITY PRECIP. LAB
ANALYSIS PERFORMED:
pH, TOTAL ACIDITY, CONDUCTIVITY, $SO_4^=$, $N\text{-}NO_3^-$, Cl^-, $N\text{-}NH_4^+$, Na^+, K^+, Ca^{++}, Mg^{++}
RESULTS ENTERED INTO LIS AS ANALYSIS IS COMPLETED
IONIC BALANCE PERFORMED WHEN ANALYSES ARE COMPLETE
RESULTS APPROVED BY LAB SUPERVISOR

Figure 23. Laboratory Sampling Handling

Air Samples

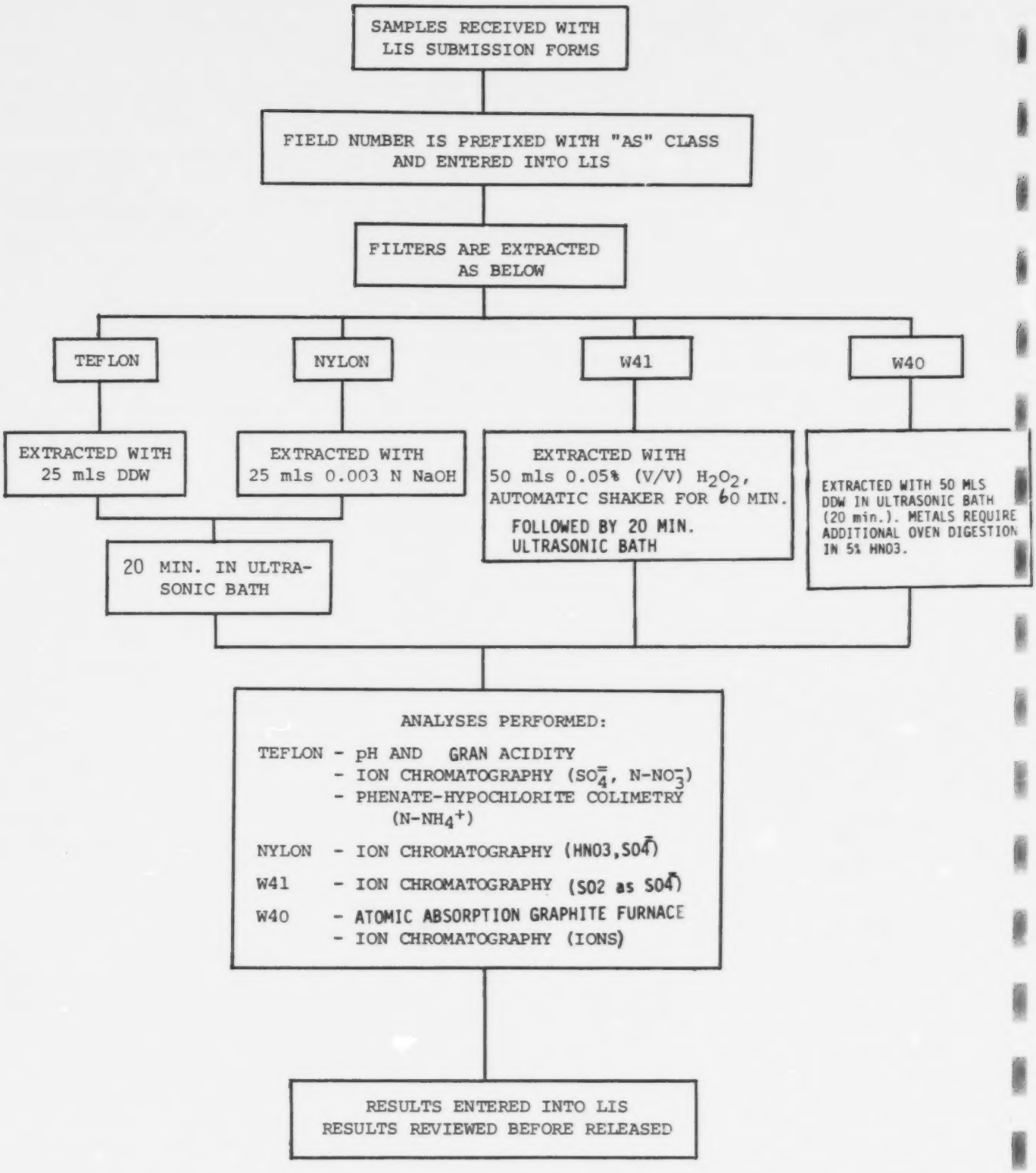

SAMPLES RECEIVED WITH LIS SUBMISSION FORMS
FIELD NUMBER IS PREFIXED WITH "AS" CLASS AND ENTERED INTO LIS
FILTERS ARE EXTRACTED AS BELOW
TEFLON
NYLON
W41
W40
EXTRACTED WITH 25 mls DDW
EXTRACTED WITH 25 mls 0.003 N NaOH
EXTRACTED WITH 50 mls 0.05% (V/V) H_2O_2, AUTOMATIC SHAKER FOR 60 MIN. FOLLOWED BY 20 MIN. ULTRASONIC BATH
EXTRACTED WITH 50 MLS DDW IN ULTRASONIC BATH (20 min.). METALS REQUIRE ADDITIONAL OVEN DIGESTION IN 5% HNO3.
20 MIN. IN ULTRA-SONIC BATH
ANALYSES PERFORMED:
TEFLON - pH AND GRAN ACIDITY
- ION CHROMATOGRAPHY ($SO_4^{=}$, $N\text{-}NO_3^{-}$)
- PHENATE-HYPOCHLORITE COLIMETRY ($N\text{-}NH_4^{+}$)
NYLON - ION CHROMATOGRAPHY (HNO3, $SO_4^{=}$)
W41 - ION CHROMATOGRAPHY (SO2 as $SO_4^{=}$)
W40 - ATOMIC ABSORPTION GRAPHITE FURNACE
- ION CHROMATOGRAPHY (IONS)
RESULTS ENTERED INTO LIS
RESULTS REVIEWED BEFORE RELEASED

Figure 24. Laboratory Sample Handling

Cumulative Precipitation Samples

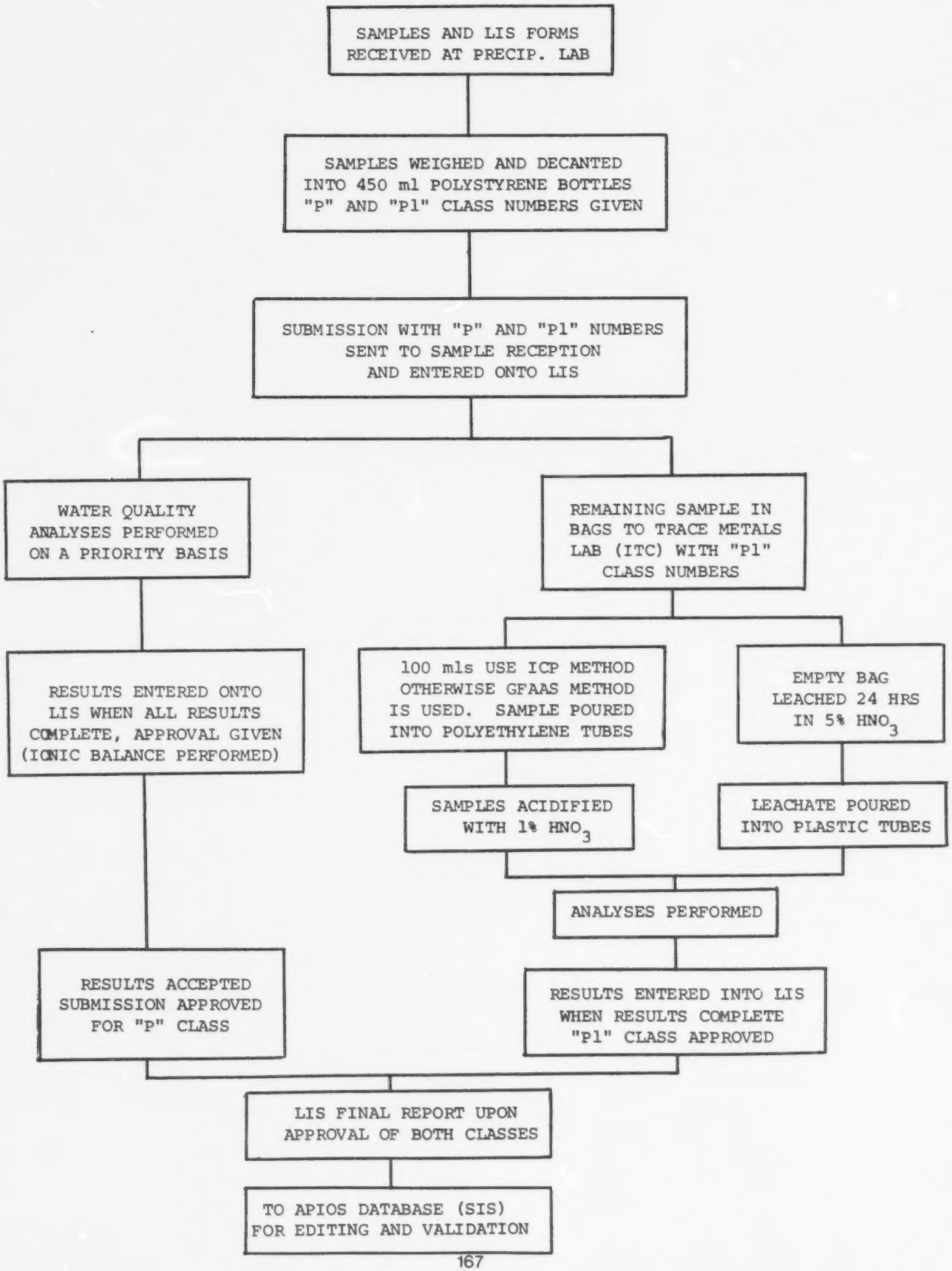

SAMPLES AND LIS FORMS RECEIVED AT PRECIP. LAB
SAMPLES WEIGHED AND DECANTED INTO 450 ml POLYSTYRENE BOTTLES "P" AND "P1" CLASS NUMBERS GIVEN
SUBMISSION WITH "P" AND "P1" NUMBERS SENT TO SAMPLE RECEPTION AND ENTERED ONTO LIS
WATER QUALITY ANALYSES PERFORMED ON A PRIORITY BASIS
REMAINING SAMPLE IN BAGS TO TRACE METALS LAB (ITC) WITH "P1" CLASS NUMBERS
RESULTS ENTERED ONTO LIS WHEN ALL RESULTS COMPLETE, APPROVAL GIVEN (IONIC BALANCE PERFORMED)
100 mls USE ICP METHOD OTHERWISE GFAAS METHOD IS USED. SAMPLE POURED INTO POLYETHYLENE TUBES
EMPTY BAG LEACHED 24 HRS IN 5% HNO_3
SAMPLES ACIDIFIED WITH 1% HNO_3
LEACHATE POURED INTO PLASTIC TUBES
ANALYSES PERFORMED
RESULTS ACCEPTED SUBMISSION APPROVED FOR "P" CLASS
RESULTS ENTERED INTO LIS WHEN RESULTS COMPLETE "P1" CLASS APPROVED
LIS FINAL REPORT UPON APPROVAL OF BOTH CLASSES
TO APIOS DATABASE (SIS) FOR EDITING AND VALIDATION

Fig. 25. Data Handling Procedures

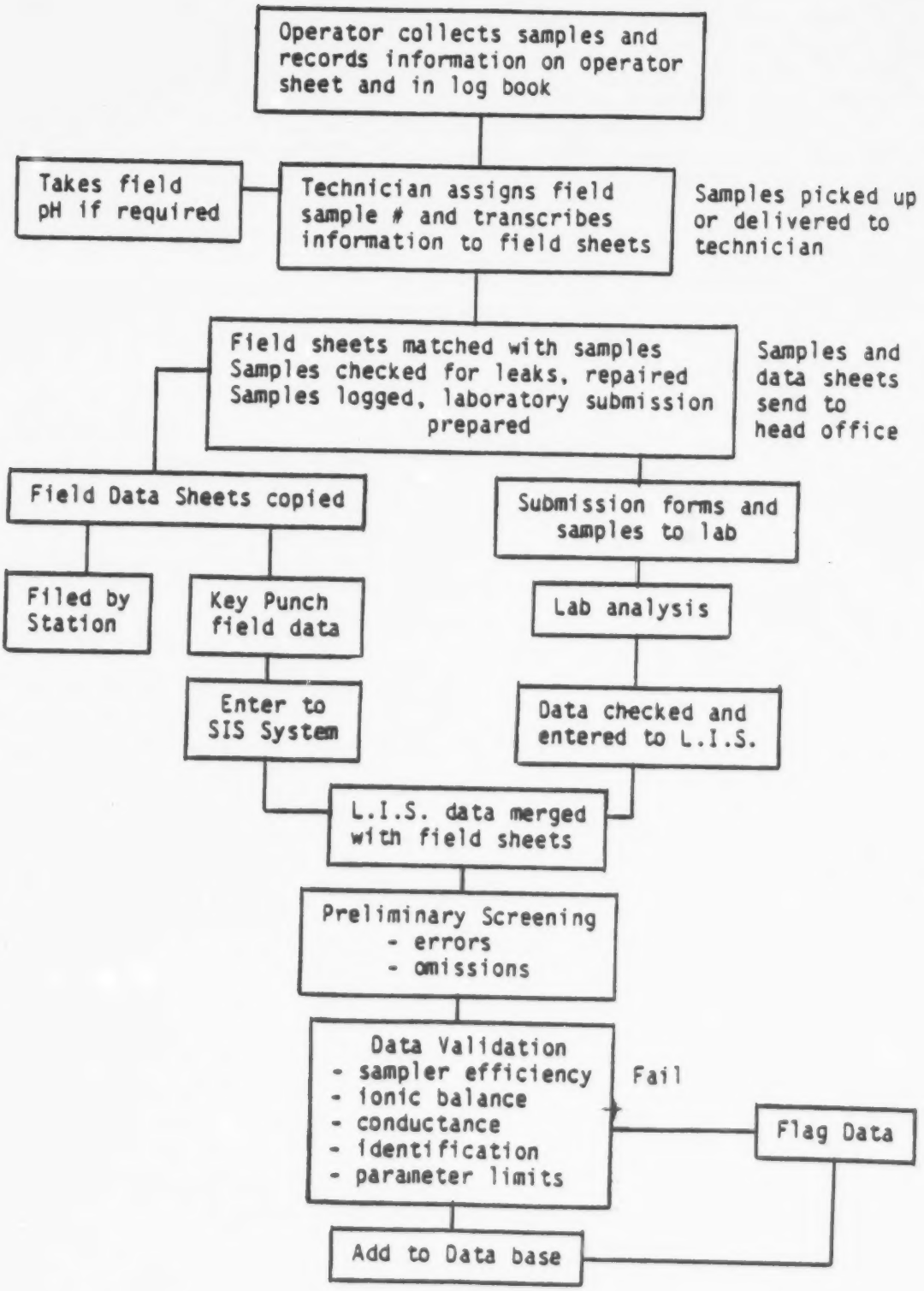

Operator collects samples and records information on operator sheet and in log book
Takes field pH if required
Technician assigns field sample # and transcribes information to field sheets
Samples picked up or delivered to technician
Field sheets matched with samples
Samples checked for leaks, repaired
Samples logged, laboratory submission prepared
Samples and data sheets send to head office
Field Data Sheets copied
Submission forms and samples to lab
Filed by Station
Key Punch field data
Lab analysis
Enter to SIS System
Data checked and entered to L.I.S.
L.I.S. data merged with field sheets
Preliminary Screening
- errors
- omissions
Data Validation
- sampler efficiency
- ionic balance
- conductance
- identification
- parameter limits
Fail
Flag Data
Add to Data base

Fig. 26. Merging and Editing of Field and Laboratory Data

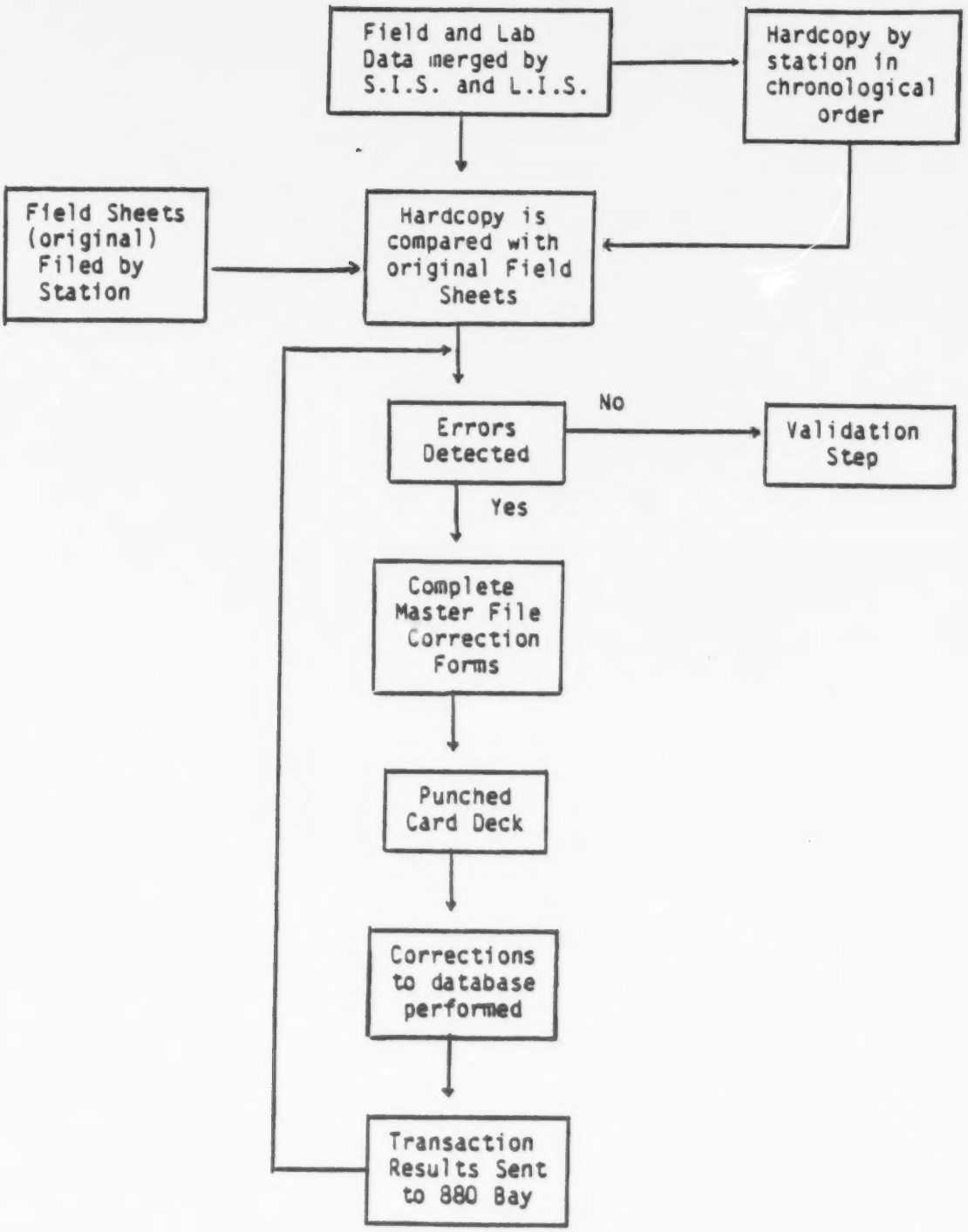

Field and Lab Data merged by S.I.S. and L.I.S.
Hardcopy by station in chronological order
Field Sheets (original) Filed by Station
Hardcopy is compared with original Field Sheets
Errors Detected
No
Validation Step
Yes
Complete Master File Correction Forms
Punched Card Deck
Corrections to database performed
Transaction Results Sent to 880 Bay

Fig. 27. Data Validation Procedures

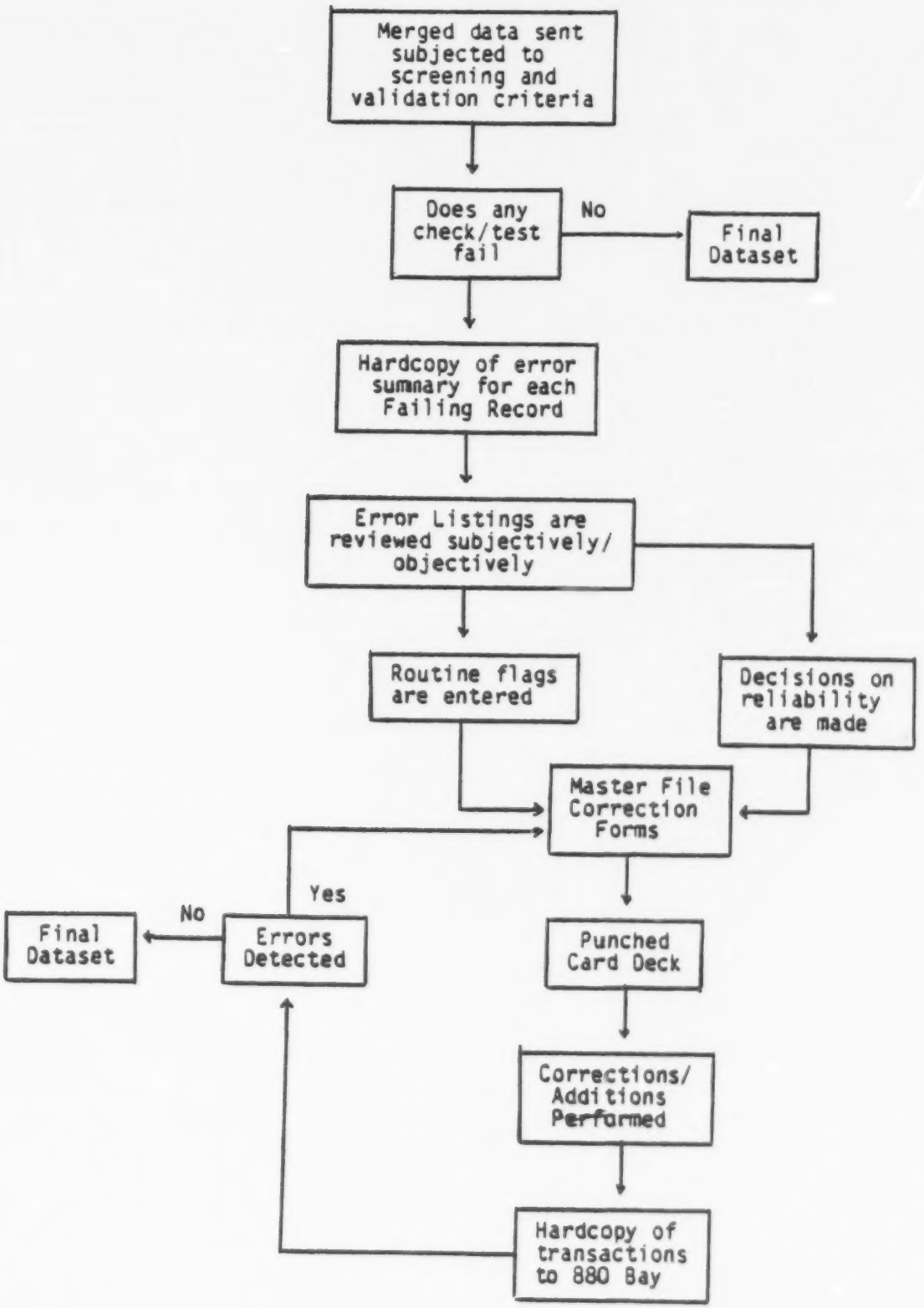


Fig.28 Event Precipitation Data Reporting Format

ONTARIO MINISTRY OF THE ENVIRONMENT
DAILY SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : NITHGROVE/DAILY/AEROCHEM #07 PAGE : 4

REMOVAL DATE	EXPOSURE DATE	SAMPLING START HR.	SAMPLING END HR.	PRECIP START HR.	PRECIP END HR.	SAMPLE TYPE 01-RAIN 02-SNOW 03-COMP/04-OTHER	GAUGE DEPTH(MM)	GAUGE TYPE 01-STD. 02-NIPHER	SAMPLE NUMBER	PROJECT CODE 02-APIOS 03-SPECIAL	SUBPROJECT CODE 01-MOE 03-AES		SAMPLER EFFICIENCY (%)	COMMENTS FIELD	COMMENTS OFFICE
APR 25,84	APR 24,84	730	730	730	930	1	1.2	1	56904	2	1		39		N
APR 30,84	APR 29,84	730	730	600	630	1	2.0	1	56905	2	1		85		
MAY 1,84	APR 30,84	730	800	1000	1100	3	5.0	1	56906	2	1	U	51	FI	
MAY 2,84	MAY 1,84	800	730	1400	1500	2	2.0	1	56907	2	1		24		N
MAY 4,84	MAY 3,84	730	800	500	800	1	4.8	1	56908	2	1		36		N
MAY 5,84	MAY 4,84	800	730	800	1100	1	2.2	1	56909	2	1		75		
MAY 8,84	MAY 7,84	730	730	100	300	1	7.8	1	56910	2	1		95		
MAY 9,84	MAY 8,84	730	730	830	1130	1	20.6	1	56911	2	1		96		
MAY 10,84	MAY 9,84	730	700	1000	1100	1	2.2	1	56914	2	1		51		
MAY 12,84	MAY 11,84	730	800	100	230	1	6.8	1	56915	2	1	U	93	QG	
MAY 22,84	MAY 21,84	730	700	530	700	1	3.2	1	56920	2	1		93		
MAY 23,84	MAY 22,84	700	700	1530	1600	1	38.8	1	56921	2	1	U	73	FI	
MAY 25,84	MAY 24,84	700	730	430	500	1	0.6	1	56922	2	1		78		
MAY 26,84	MAY 25,84	730	800	430	530	1	22.8	1	56923	2	1		97		
MAY 29,84	MAY 28,84	700	700	430	700	1	11.4	1	56924	2	1		92		
MAY 30,84	MAY 29,84	700	700	700	900	1	6.3	1	56925	2	1		62		J
MAY 31,84	MAY 30,84	700	700	700	800	1	1.2	1	56926	2	1		20	C	N
JUN 7,84	JUN 6,84	700	700	500	530	1	1.0	1	56927	2	1		59		
JUN 8,84	JUN 7,84	700	700	1730	1800	1	8.6	1	56928	2	1		110		
JUN 12,84	JUN 10,84	700	700	1730	1830	1	****	1	56929	2	1		****	C	HZ
JUN 13,84	JUN 12,84	700	730	430	530	1	4.4	1	56930	2	1		104		
JUN 18,84	JUN 17,84	700	700	430	600	1	****	1	56931	2	1		****		C
JUN 19,84	JUN 18,84	700	700	830	1000	1	2.4	1	56932	2	1		54		
JUN 24,84	JUN 23,84	700	800	630	730	1	7.8	1	56933	2	1		97		
JUN 25,84	JUN 24,84	800	800	330	430	1	5.4	1	56934	2	1		89	B	
JUN 28,84	JUN 27,84	700	700	1030	100	1	33.4	1	56935	2	1		103		
JUL 4,84	JUL 3,84	700	700	400	430	1	1.4	1	56936	2	1		44		N
JUL 7,84	JUL 6,84	700	700	1030	1200	1	14.8	1	56937	2	1		98		
JUL 8,84	JUL 7,84	700	800	700	800	1	2.4	1	56940	2	1		105		
JUL 11,84	JUL 10,84	700	700	530	700	1	13.4	1	56941	2	1		101		
JUL 12,84	JUL 11,84	700	700	700	1000	1	21.4	1	56942	2	1		95		
JUL 14,84	JUL 13,84	700	800	500	545	1	8.4	1	56943	2	1		108		J
JUL 15,84	JUL 14,84	800	800	530	600	1	0.8	1	56944	2	1		56		
JUL 16,84	JUL 15,84	800	700	1830	1930	1	10.1	1	56945	2	1		91		
JUL 18,84	JUL 17,84	700	730	1600	1900	1	22.8	1	56946	2	1		60		
JUL 23,84	JUL 22,84	700	700	1530	1630	1	2.2	1	56948	2	1		73		
JUL 27,84	JUL 26,84	700	700	1430	1500	1	2.2	1	56949	2	1		86		
JUL 31,84	JUL 30,84	700	700	900	930	1	1.2	1	56950	2	1		36		N
AUG 1,84	JUL 31,84	700	800	500	600	1	2.4	1	56951	2	1		86		
AUG 2,84	AUG 1,84	800	700	1200	1500	1	8.2	1	56952	2	1		89		

Fig.28 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
DAILY SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : NITHGROVE/DAILY/AEROCHEM 807 PAGE : 5

REMOVAL DATE	EXPOSURE DATE	VOLUME ML	CONDUCT. UMHO/CM	PH FIELD	PH LAB	TOTAL H+ TO PH8.3 MG/L	SULPHATE MG/L	NITRATE AS N MG/L
APR 25,84	APR 24,84	30.0	******	******	4.96	0.0412	******	******
APR 30,84	APR 29,84	110.0	G 96.5	******	4.06	0.2020	A 14.55	A 2.26
MAY 1,84	APR 30,84	164.0	20.0	******	4.63	0.0556	2.95	0.24
MAY 2,84	MAY 1,84	31.0	******	******	G 7.44	0.0190	******	******
MAY 4,84	MAY 3,84	112.0	23.7	******	4.38	0.0792	2.85	0.36
MAY 5,84	MAY 4,84	106.0	20.5	******	4.45	D 0.0702	1.75	0.26
MAY 8,84	MAY 7,84	478.0	82.5	3.88	3.92	0.1798	8.15	1.76
MAY 9,84	MAY 8,84	1279.0	D 22.0	4.50	4.51	0.0620	D 2.20	0.30
MAY 10,84	MAY 9,84	73.0	******	******	5.00	0.0374	1.50	0.17
MAY 12,84	MAY 11,84	409.0	******	3.95	******	******	******	******
MAY 22,84	MAY 21,84	191.0	> 100.0	3.59	3.61	G 0.2960	12.00	1.87
MAY 23,84	MAY 22,84	1827.0	28.4	4.32	4.41	0.0656	3.50	0.48
MAY 25,84	MAY 24,84	30.0	******	******	4.29	0.0950	6.15	1.35
MAY 26,84	MAY 25,84	1431.0	25.7	4.27	4.36	0.0706	2.60	0.37
MAY 29,84	MAY 28,84	677.0	13.0	4.54	4.66	0.0466	1.25	0.12
MAY 30,84	MAY 29,84	251.0	9.0	G 5.90	B 6.60	0.0360	1.20	0.17
MAY 31,84	MAY 30,84	16.0	******	******	D 5.25	0.0290	******	******
JUN 7,84	JUN 6,84	38.0	******	******	4.04	0.1542	D 10.50	1.76
JUN 8,84	JUN 7,84	610.0	27.8	4.18	4.36	0.0708	3.45	0.30
JUN 12,84	JUN 10,84	176.0	27.2	4.69	5.14	0.0372	5.10	0.72
JUN 13,84	JUN 12,84	296.0	56.5	3.90	3.98	0.1448	4.95	0.99
JUN 18,84	JUN 17,84	336.0	26.1	4.23	4.19	0.0740	3.10	0.43
JUN 19,84	JUN 18,84	84.0	21.9	******	4.54	0.0554	D 3.10	0.43
JUN 24,84	JUN 23,84	487.0	19.1	4.37	4.44	0.0532	1.85	0.14
JUN 25,84	JUN 24,84	311.0	60.0	3.82	3.85	0.1666	7.45	0.66
JUN 28,84	JUN 27,84	2219.0	22.8	4.30	4.33	0.0708	2.70	0.29
JUL 4,84	JUL 3,84	40.0	******	******	3.37	B ******	10.00	2.00
JUL 7,84	JUL 6,84	935.0	19.8	4.37	4.42	0.0582	1.90	0.40
JUL 8,84	JUL 7,84	162.0	6.1	******	5.07	0.0260	0.75	0.04
JUL 11,84	JUL 10,84	875.0	25.5	4.15	4.23	0.0782	2.65	0.36
JUL 12,84	JUL 11,84	1314.0	15.2	4.42	4.52	0.0478	2.05	0.13
JUL 14,84	JUL 13,84	586.0	13.3	4.59	5.06	0.0298	1.85	0.38
JUL 15,84	JUL 14,84	29.0	******	******	3.66	0.2700	> 10.00	> 2.00
JUL 16,84	JUL 15,84	595.0	46.2	3.94	3.96	0.1338	5.70	0.49
JUL 18,84	JUL 17,84	890.0	17.1	4.41	4.54	0.0488	1.90	0.37
JUL 23,84	JUL 22,84	103.0	45.1	******	4.15	0.1054	5.45	1.14
JUL 27,84	JUL 26,84	122.0	11.0	******	4.66	0.0410	1.10	0.08
JUL 31,84	JUL 30,84	28.0	******	******	4.88	0.0376	******	******
AUG 1,84	JUL 31,84	133.0	28.5	******	4.25	0.0722	2.95	0.42
AUG 2,84	AUG 1,84	473.0	21.0	4.28	4.33	0.0614	2.55	0.13

Fig.28 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
DAILY SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : NITHGROVE/DAILY/AEROCHEM 807 PAGE : 6

REMOVAL DATE	EXPOSURE DATE	CALCIUM MG/L	CHLORIDE MG/L	MAGNESIM MG/L	POTASSIM MG/L	SODIUM MG/L	AMMONIUM AS N MG/L	FREE H+ LAB MG/L
APR 25,84	APR 24,84	******	******	******	******	******	******	0.0110
APR 30,84	APR 29,84	B 3.00	A 1.70	G 0.330	G 0.830	B 0.960	G 3.100	0.0871
MAY 1,84	APR 30,84	0.48	0.26	G 0.085	0.120	0.145	0.365	0.0234
MAY 2,84	MAY 1,84	******	******	******	******	******	******	G 0.0000
MAY 4,84	MAY 3,84	0.39	0.27	0.075	0.050	0.190	0.070	0.0417
MAY 5,84	MAY 4,84	0.25	0.17	0.040	0.045	D 0.120	0.145	0.0355
MAY 8,84	MAY 7,84	0.90	0.37	0.175	0.095	0.115	1.750	0.1202
MAY 9,84	MAY 8,84	0.26	0.14	0.040	0.025	0.065	0.290	0.0309
MAY 10,84	MAY 9,84	******	0.33	******	******	******	0.150	0.0100
MAY 12,84	MAY 11,84	******	******	******	******	******	******	******
MAY 22,84	MAY 21,84	D 0.55	B 0.79	D 0.130	B 0.355	B 0.405	1.350	0.2455
MAY 23,84	MAY 22,84	0.25	0.20	0.060	0.040	0.090	0.650	0.0389
MAY 25,84	MAY 24,84	******	G 0.87	******	******	******	******	0.0513
MAY 26,84	MAY 25,84	0.13	0.11	0.020	0.020	D 0.150	0.285	0.0437
MAY 29,84	MAY 28,84	0.07	0.11	0.015	0.045	0.030	0.085	0.0219
MAY 30,84	MAY 29,84	0.10	0.23	0.025	0.105	> 1.000	0.120	B 0.0003
MAY 31,84	MAY 30,84	******	******	******	******	******	******	D 0.0056
JUN 7,84	JUN 6,84	******	G 0.84	******	******	******	******	0.0912
JUN 8,84	JUN 7,84	0.29	0.08	0.040	0.030	0.040	0.475	0.0437
JUN 12,84	JUN 10,84	G 1.24	0.44	0.280	G 0.155	0.295	1.000	0.0072
JUN 13,84	JUN 12,84	0.52	0.30	0.135	0.100	0.105	0.370	0.1047
JUN 18,84	JUN 17,84	0.06	0.15	D 0.015	D 0.070	D 0.055	0.520	0.0646
JUN 19,84	JUN 18,84	******	D 0.32	******	******	******	0.730	0.0288
JUN 24,84	JUN 23,84	0.02	0.08	0.005	0.040	0.030	0.120	0.0363
JUN 25,84	JUN 24,84	0.12	0.22	0.020	0.090	0.065	0.740	0.1413
JUN 28,84	JUN 27,84	0.10	0.07	0.015	0.020	<M 0.005	0.335	0.0468
JUL 4,84	JUL 3,84	******	0.69	******	******	******	******	0.4266
JUL 7,84	JUL 6,84	0.10	0.10	0.020	D 0.030	<T 0.015	D 0.330	0.0380
JUL 8,84	JUL 7,84	0.16	0.09	0.025	0.035	0.035	0.025	0.0085
JUL 11,84	JUL 10,84	0.09	0.18	0.010	0.070	0.075	0.205	0.0589
JUL 12,84	JUL 11,84	0.04	0.17	0.005	0.095	0.080	0.275	0.0302
JUL 14,84	JUL 13,84	0.48	0.11	0.080	0.025	<T 0.015	0.445	0.0087
JUL 15,84	JUL 14,84	******	0.60	******	******	******	******	0.2188
JUL 16,84	JUL 15,84	0.23	0.16	0.030	0.030	<T 0.015	0.445	0.1096
JUL 18,84	JUL 17,84	0.25	0.13	0.045	0.020	<T 0.010	0.310	0.0288
JUL 23,84	JUL 22,84	1.10	0.20	0.250	0.065	0.185	0.665	0.0708
JUL 27,84	JUL 26,84	0.10	0.09	0.020	0.035	0.045	0.055	0.0219
JUL 31,84	JUL 30,84	******	******	******	******	******	******	0.0132
AUG 1,84	JUL 31,84	0.25	0.23	0.065	0.105	0.105	0.210	0.0562
AUG 2,84	AUG 1,84	0.03	0.10	0.010	D 0.065	D 0.050	0.270	0.0468

Fig.29 Cumulative Precipitation Data Reporting Format

ONTARIO MINISTRY OF THE ENVIROMIENT
CUMULATIVE SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/CUMULATIVE PRECIP. #20 PAGE : 1

REMOVAL DATE	EXPOSURE DATE	SAMPLING START HR.	SAMPLING END HR.	SAMPLE TYPE 01-RAIN 02-SNOW 03-COMP/04-OTHER	GAUGE DEPTH(MM)	GAUGE TYPE 00-APIOS 09-AES	SAMPLE NUMBER	PROJECT CODE 02-APIOS 03-SPECIAL	SUBPROJECT CODE 01-MOE 03-AES	SAMPLER EFFICIENCY (%)	COMMENTS FIELD	COMMENTS OFFICE
FEB 1,83	JAN 4,83	1000	835	4	66.0	0	29169	2	1	U 81	FL	
MAR 1,83	FEB 1,83	840	825	4	43.0	0	29179	2	1	94		
MAR 29,83	MAR 1,83	825	900	4	54.0	0	29187	2	1	73		MM
APR 26,83	MAR 29,83	900	910	1	66.0	0	29195	2	1	83		
MAY 24,83	APR 26,83	910	840	1	163.0	0	29207	2	1	89		
JUN 21,83	MAY 24,83	840	1500	1	32.0	0	29213	2	1	84		
JUL 19,83	JUN 21,83	1500	830	1	27.0	0	29229	2	1	93	BC	
AUG 16,83	JUL 19,83	830	845	1	47.0	0	29236	2	1	100		
SEP 13,83	AUG 16,83	845	930	1	64.0	0	29245	2	1	89	A	
OCT 11,83	SEP 13,83	930	900	1	149.0	0	29248	2	1	94		
NOV 8,83	OCT 11,83	900	900	1	87.0	0	29256	2	1	95		
DEC 6,83	NOV 8,83	900	1120	2	79.0	0	29260	2	1	86		MM
JAN 3,84	DEC 6,83	1120	1500	3	90.0	0	29266	2	1	85		

REMOVAL DATE	EXPOSURE DATE	VOLUME ML	CONDUCT. UMHO/CM	PH LAB	TOTAL H+ TO PH8.3 MG/L	SULPHATE MG/L	NITRATE AS N MG/L	CALCIUM MG/L
FEB 1,83	JAN 4,83	1736.0	28.6	4.26	0.1000	1.80	0.52	0.05
MAR 1,83	FEB 1,83	1527.0	31.4	4.16	0.0918	2.20	0.52	0.06
MAR 29,83	MAR 1,83	1295.0	31.8	4.28	0.0810	2.40	0.53	0.10
APR 26,83	MAR 29,83	1800.0	32.5	4.31	0.0816	2.90	0.39	0.24
MAY 24,83	APR 26,83	4730.0	25.9	4.35	0.0704	2.75	0.39	0.30
JUN 21,83	MAY 24,83	882.0	46.8	4.17	0.1130	5.45	0.83	0.63
JUL 19,83	JUN 21,83	817.0	32.0	4.31	0.0856	4.20	0.42	0.41
AUG 16,83	JUL 19,83	1535.0	28.0	4.34	0.0712	3.25	0.37	0.24
SEP 13,83	AUG 16,83	1852.0	34.5	4.30	0.0760	3.65	0.48	0.38
OCT 11,83	SEP 13,83	4556.0	24.9	4.42	0.0432	2.25	0.35	0.20
NOV 8,83	OCT 11,83	2691.0	18.5	4.50	0.0470	1.55	0.27	0.04
DEC 6,83	NOV 8,83	2228.0	27.5	4.19	0.0820	2.05	0.58	0.11
JAN 3,84	DEC 6,83	2502.0	20.3	4.41	0.0500	0.95	0.44	0.06

Fig.29 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
CUMULATIVE SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/CUMULATIVE PRECIP. #20 PAGE : 2

REMOVAL DATE	EXPOSURE DATE	CHLORIDE MG/L	KJELDAHL AS N MG/L	MAGNESIM MG/L	POTASSIM MG/L	SODIUM MG/L	AMMONIUM AS N MG/L	PHOSPHOR MG/L
FEB 1,83	JAN 4,83	0.11	0.20	<W 0.005	0.010	0.035	0.162	0.010
MAR 1,83	FEB 1,83	0.11	0.25	0.010	0.060	0.105	0.214	< 0.003
MAR 29,83	MAR 1,83	U 0.80	0.29	0.010	0.030	0.070	0.252	< 0.002
APR 26,83	MAR 29,83	0.13	0.58	0.030	0.030	0.055	0.180	0.010
MAY 24,83	APR 26,83	0.07	0.38	0.045	0.020	0.040	0.314	< 0.004
JUN 21,83	MAY 24,83	0.13	0.84	0.140	0.050	0.040	0.650	0.014
JUL 19,83	JUN 21,83	0.12	0.59	0.060	0.070	0.070	0.590	0.007
AUG 16,83	JUL 19,83	0.06	0.41	0.050	0.030	0.015	0.400	0.006
SEP 13,83	AUG 16,83	0.11	0.61	0.045	0.040	0.065	0.330	0.027
OCT 11,83	SEP 13,83	0.02	0.26	0.030	0.020	0.020	0.234	0.004
NOV 8,83	OCT 11,83	0.06	0.23	0.010	0.030	0.035	0.184	0.005
DEC 6,83	NOV 8,83	0.13	D 0.60	0.015	< 0.010	0.020	D 0.680	0.009
JAN 3,84	DEC 6,83	0.11	0.08	0.015	<W 0.005	0.045	0.048	0.005

REMOVAL DATE	EXPOSURE DATE	MANGANSE MG/L	NICKEL MG/L	ZINC MG/L	IRON MG/L	LEAD MG/L	VANADIUM MG/L	ALUMINUM MG/L
FEB 1,83	JAN 4,83	0.001	0.001	0.004	0.010	0.007	< 0.002	0.011
MAR 1,83	FEB 1,83	< 0.001	< 0.001	0.005	0.013	D 0.004	< 0.002	0.016
MAR 29,83	MAR 1,83	0.001	< 0.001	0.005	0.039	0.004	< 0.002	0.047
APR 26,83	MAR 29,83	0.002	< 0.001	0.004	0.017	0.004	< 0.002	0.031
MAY 24,83	APR 26,83	0.003	< 0.001	0.007	0.032	D 0.014	< 0.002	0.022
JUN 21,83	MAY 24,83	0.009	< 0.001	0.008	0.114	0.008	< 0.002	0.110
JUL 19,83	JUN 21,83	0.005	< 0.001	0.003	0.059	0.004	< 0.002	0.078
AUG 16,83	JUL 19,83	0.004	< 0.001	< 0.003	0.036	0.005	< 0.002	0.060
SEP 13,83	AUG 16,83	0.003	< 0.001	0.004	0.044	0.004	< 0.002	0.047
OCT 11,83	SEP 13,83	0.001	< 0.001	0.002	0.009	0.004	< 0.002	0.014
NOV 8,83	OCT 11,83	< 0.001	< 0.001	0.002	0.006	0.004	< 0.002	0.006
DEC 6,83	NOV 8,83	0.001	< 0.001	0.004	0.016	0.004	< 0.002	0.016
JAN 3,84	DEC 6,83	< 0.001	0.001	< 0.003	0.008	0.001	< 0.002	0.013

Fig.29 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
CUMULATIVE SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/CUMULATIVE PRECIP. #20

REMOVAL DATE	EXPOSURE DATE	COPPER MG/L	CADMIUM MG/L	FREE H+ MG/L
FEB 1,83	JAN 4,83	0.002	0.0004	0.0550
MAR 1,83	FEB 1,83	< 0.002	< 0.0001	0.0692
MAR 29,83	MAR 1,83	0.001	0.0001	0.0525
APR 26,83	MAR 29,83	< 0.002	0.0001	0.0490
MAY 24,83	APR 26,83	0.001	< 0.0001	0.0447
JUN 21,83	MAY 24,83	< 0.002	0.0001	0.0676
JUL 19,83	JUN 21,83	< 0.002	< 0.0001	0.0490
AUG 16,83	JUL 19,83	0.001	0.0001	0.0457
SEP 13,83	AUG 16,83	0.001	< 0.0001	0.0501
OCT 11,83	SEP 13,83	0.001	< 0.0001	0.0380
NOV 8,83	OCT 11,83	< 0.001	< 0.0001	0.0316
DEC 6,83	NOV 8,83	< 0.001	< 0.0001	0.0646
JAN 3,84	DEC 6,83	< 0.001	< 0.0001	0.0389

Fig.30 Sequential Air Sampling Data Reporting Format

ONTARIO MINISTRY OF THE ENVIRONMENT
AIR SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/DAILY/AIR 808 PAGE : 3

REMOVAL DATE	EXPOSURE DATE	SAMPLING START HR.	SAMPLING END HR.	FILTER TYPE 01-ACTIVE 02-PASSIVE 03-BLANK	FLOW VOLUME(L)	SAMPLE NUMBER	PROJECT CODE 02-APIOS 03-SPECIAL	SUBPROJECT CODE 01-MOE 03-AES 04-ON HYDRO	COMMENTS FIELD	COMMENTS OFFICE
FEB 11,84	FEB 10,84	800	800	1	25480.0	26232	2	1		
FEB 12,84	FEB 11,84	800	800	1	25181.0	26233	2	1		
FEB 13,84	FEB 12,84	800	800	1	26253.0	26234	2	1		
FEB 14,84	FEB 13,84	800	800	1	26157.0	26235	2	1		
FEB 15,84	FEB 14,84	800	800	1	27786.0	26245	2	1		
FEB 16,84	FEB 15,84	800	800	1	31110.0	26246	2	1		
FEB 17,84	FEB 16,84	800	800	1	31860.0	26247	2	1		
FEB 18,84	FEB 17,84	800	800	1	24957.0	26248	2	1		
FEB 19,84	FEB 18,84	800	800	1	23681.0	26249	2	1		
FEB 20,84	FEB 19,84	800	800	1	28304.0	26250	2	1		
FEB 21,84	FEB 20,84	800	800	1	29574.0	26251	2	1		
FEB 22,84	FEB 21,84	800	800	1	25791.0	26260	2	1		
FEB 23,84	FEB 22,84	800	800	1	23470.0	26261	2	1		
FEB 24,84	FEB 23,84	800	800	1	25180.0	26262	2	1		
FEB 25,84	FEB 24,84	800	800	1	26690.0	26263	2	1		
FEB 26,84	FEB 25,84	800	800	1	27340.0	26264	2	1		
FEB 27,84	FEB 26,84	800	800	1	27440.0	26265	2	1		
FEB 28,84	FEB 27,84	800	800	1	27260.0	26266	2	1		
FEB 29,84	FEB 28,84	800	800	1	25300.0	26276	2	1		
MAR 1,84	FEB 29,84	800	800	1	25830.0	26277	2	1		
MAR 2,84	MAR 1,84	800	800	1	27530.0	26278	2	1		
MAR 3,84	MAR 2,84	800	800	1	27340.0	26279	2	1		
MAR 4,84	MAR 3,84	800	800	1	27970.0	26280	2	1		
MAR 5,84	MAR 4,84	800	800	1	27920.0	26281	2	1		
MAR 6,84	MAR 5,84	800	800	1	27050.0	26282	2	1		
MAR 7,84	MAR 6,84	800	800	1	25070.0	26292	2	1		
MAR 8,84	MAR 7,84	800	800	1	26180.0	26293	2	1		
MAR 9,84	MAR 8,84	800	800	1	27750.0	26294	2	1		
MAR 10,84	MAR 9,84	800	800	1	26940.0	26295	2	1		
MAR 11,84	MAR 10,84	800	800	1	27590.0	26296	2	1		
MAR 12,84	MAR 11,84	800	800	1	28410.0	26297	2	1		
MAR 13,84	MAR 12,84	800	800	1	24770.0	26298	2	1		
MAR 14,84	MAR 13,84	800	800	1	25460.0	26308	2	1		
MAR 15,84	MAR 14,84	800	800	1	25280.0	26309	2	1		
MAR 16,84	MAR 15,84	800	800	1	25990.0	26310	2	1		
MAR 19,84	MAR 16,84	800	800	1	62810.0	26311	2	1	A	Z
MAR 20,84	MAR 19,84	800	830	1	27290.0	26312	2	1	A	
MAR 22,84	MAR 20,84	830	800	1	47830.0	26322	2	1	A	Z
MAR 23,84	MAR 22,84	800	800	1	24370.0	26323	2	1		
MAR 24,84	MAR 23,84	800	800	1	27000.0	26324	2	1		

Fig.30 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
AIR SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : DORSET/DAILY/AIR 808 PAGE : 4

REMOVAL DATE	EXPOSURE DATE	SULPHUR DIOXIDE UG/M**3		SULPHATE UG/M**3		NITRIC AS N UG/M**3		AMMONIUM AS N UG/M**3		NITRATE AS N UG/M**3		TOTL NO3 AS N UG/M**3
FEB 11,84	FEB 10,84	41.19		8.98		1.53	>	1.952		0.03		1.56
FEB 12,84	FEB 11,84	7.18		8.24		2.96		1.727	<W	0.01		2.96
FEB 13,84	FEB 12,84	3.81	G	10.86		0.84		0.409	<W	0.01		0.84
FEB 14,84	FEB 13,84	5.23		5.26		0.48		0.927	<W	0.01		0.48
FEB 15,84	FEB 14,84	2.66		3.69		0.64		1.022		0.08		0.72
FEB 16,84	FEB 15,84	1.17		1.97		0.16		0.529	<W	0.01		0.16
FEB 17,84	FEB 16,84	0.62		0.75		0.06		0.184	<T	0.01		0.06
FEB 18,84	FEB 17,84	0.26		1.25		0.17		0.293	<W	0.01		0.17
FEB 19,84	FEB 18,84	5.06		6.55		1.96		1.645		0.02		1.98
FEB 20,84	FEB 19,84	5.70		5.78		0.86		1.367	<W	0.01		0.86
FEB 21,84	FEB 20,84	3.37		2.83		0.08		0.100	<W	0.01		0.08
FEB 22,84	FEB 21,84	4.88		1.94		0.07		0.185	<W	0.01		0.07
FEB 23,84	FEB 22,84	9.62		4.47		0.49		2.284	G	1.23		1.72
FEB 24,84	FEB 23,84	16.08		5.56		0.61		2.626	G	1.08		1.69
FEB 25,84	FEB 24,84	3.68		4.54		0.67		1.307		0.06		0.73
FEB 26,84	FEB 25,84	4.08		1.05		0.02		0.142	<W	0.01		0.02
FEB 27,84	FEB 26,84	5.55		0.64		0.03		0.165	<W	0.01		0.03
FEB 28,84	FEB 27,84	6.60		0.69		0.05		0.133	<T	0.01		0.06
FEB 29,84	FEB 28,84	3.23		0.35		0.02		0.087	<W	0.01		0.02
MAR 1,84	FEB 29,84	1.23		0.73		0.01		0.079	<W	0.01		0.01
MAR 2,84	MAR 1,84	12.02		0.68		0.02		0.098	<W	0.01		0.02
MAR 3,84	MAR 2,84	25.76		1.37		0.03		0.082	<W	0.01		0.03
MAR 4,84	MAR 3,84	6.08		1.34		0.02		0.148	<T	0.01		0.03
MAR 5,84	MAR 4,84	5.64		0.76		0.08		0.224	<T	0.01		0.08
MAR 6,84	MAR 5,84	8.38		3.65		0.41		0.649	<W	0.01		0.41
MAR 7,84	MAR 6,84	10.39		1.50		0.07		0.150		0.07		0.14
MAR 8,84	MAR 7,84	3.23		2.82		0.03		0.383		0.04		0.07
MAR 9,84	MAR 8,84	3.23		2.61		0.06		0.334	<T	0.01		0.06
MAR 10,84	MAR 9,84	2.10		1.63		0.09		0.258	<T	0.01		0.09
MAR 11,84	MAR 10,84	6.39		4.89		0.66		1.173		0.12		0.77
MAR 12,84	MAR 11,84	1.80		2.42		0.03		0.277		0.04		0.07
MAR 13,84	MAR 12,84	2.84		2.12		0.03		0.223		0.06		0.10
MAR 14,84	MAR 13,84	8.90		3.58		0.59		0.668		0.03		0.62
MAR 15,84	MAR 14,84	9.65		6.53		0.48		0.698	<W	0.01		0.48
MAR 16,84	MAR 15,84	8.85		8.70		0.81		1.285	<W	0.01		0.81
MAR 19,84	MAR 16,84	2.52		2.52		0.08		0.192	<W	0.00		0.08
MAR 20,84	MAR 19,84	0.39		2.29		0.05		0.171	<W	0.01		0.05
MAR 22,84	MAR 20,84	6.84		4.60		0.74		0.795		0.01		0.75
MAR 23,84	MAR 22,84	9.24		2.51		0.28		0.310	<T	0.01		0.29
MAR 24,84	MAR 23,84	2.08		2.13		0.16		0.243		0.02		0.18

Fig.31 Low Volume Air Sampling Data Reporting Format

ONTARIO MINISTRY OF THE ENVIRONMENT
AIR SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : GOWGANDA/CUMULATIVE/LO-VOL #25 PAGE : 1

REMOVAL DATE	EXPOSURE DATE	SAMPLING START HR.	SAMPLING END HR.	FLOW VOLUME(L)	SAMPLE NUMBER	PROJECT CODE 02-APIOS 03-SPECIAL	SUBPROJECT CODE 01-MOE 03-AES 04-ON HYDRO	COMMENTS FIELD	COMMENTS OFFICE
FEB 1,83	JAN 4,83	845	1030	64100.0	35077	2	1		
MAR 1,83	FEB 1,83	1030	1200	79010.0	35082	2	1		
MAR 29,83	MAR 1,83	1200	1118	91120.0	35086	2	1		
APR 26,83	MAR 29,83	1118	1030	87610.0	35094	2	1		
MAY 24,83	APR 26,83	1030	1030	82190.0	35100	2	1		
JUN 21,83	MAY 24,83	1045	1245	77280.0	35106	2	1		
JUL 19,83	JUN 21,83	1245	1145	74060.0	35112	2	1		
AUG 16,83	JUL 19,83	1145	1040	75602.0	35118	2	1		
SEP 13,83	AUG 16,83	1040	1230	83948.0	35124	2	1		
OCT 11,83	SEP 13,83	1230	1850	86216.0	35130	2	1		
NOV 8,83	OCT 11,83	1850	1315	84357.0	35136	2	1		
DEC 6,83	NOV 8,83	1315	1115	27772.0	35144	2	1	B	F
JAN 3,84	DEC 6,83	1115	1300	77899.5	35152	2	1		

REMOVAL DATE	EXPOSURE DATE	SULPHUR DIOXIDE UG/M**3	SULPHATE UG/M**3	TOTAL N -NITRATE UG/M**3	CHLORIDE UG/M**3	CALCIUM UG/M**3	MAGNESIM UG/M**3	POTASSIM UG/M**3
FEB 1,83	JAN 4,83	3.59	2.57	0.346	0.156	0.071	0.036	0.035
MAR 1,83	FEB 1,83	4.99	2.70	0.325	0.044	0.053	0.020	0.038
MAR 29,83	MAR 1,83	3.48	2.27	0.137	0.110	< 0.110	< 0.027	D 0.115
APR 26,83	MAR 29,83	1.40	1.85	0.074	0.074	0.063	0.041	D 0.138
MAY 24,83	APR 26,83	2.96	1.82	0.100	0.085	0.118	0.048	0.027
JUN 21,83	MAY 24,83	3.53	4.43	0.071	0.091	0.135	0.100	0.034
JUL 19,83	JUN 21,83	1.08	1.92	0.213	0.149	0.165	0.055	0.041
AUG 16,83	JUL 19,83	2.42	2.54	0.132	0.146	0.063	0.042	0.040
SEP 13,83	AUG 16,83	1.69	3.84	0.152	*******	0.124	0.047	0.054
OCT 11,83	SEP 13,83	3.68	3.57	0.188	0.174	0.079	0.028	0.043
NOV 8,83	OCT 11,83	3.99	1.52	0.240	0.089	0.101	0.023	0.036
DEC 6,83	NOV 8,83	3.54	1.53	0.171	0.252	< 0.036	0.014	<T 0.018
JAN 3,84	DEC 6,83	6.03	1.96	0.154	0.270	0.023	0.032	0.026

Fig.31 (cont'd)

ONTARIO MINISTRY OF THE ENVIRONMENT
AIR SAMPLING ANALYSIS RESULTS
APIOS - ACIDIC PRECIPITATION IN ONTARIO STUDY

STATION NAME : GOWGANDA/CUMULATIVE/LO-VOL #25 PAGE : 2

REMOVAL DATE	EXPOSURE DATE	SODIUM UG/M**3	IRON UG/M**3	ALUMINIUM UG/M**3	LEAD UG/M**3	MANGANSE UG/M**3	COPPER UG/M**3	NICKEL UG/M**3
FEB 1,83	JAN 4,83	0.169	0.024	0.017	0.024	0.0008	0.0012	< 0.00078
MAR 1,83	FEB 1,83	0.111	0.025	0.005	0.033	0.0032	0.0016	< 0.00063
MAR 29,83	MAR 1,83	0.159	0.082	0.076	0.021	0.0027	D 0.0060	< 0.00055
APR 26,83	MAR 29,83	0.095	0.086	0.034	0.022	0.0023	0.0023	< 0.00057
MAY 24,83	APR 26,83	0.066	0.092	0.056	0.028	0.0030	0.0024	< 0.00061
JUN 21,83	MAY 24,83	0.068	0.210	0.088	0.028	0.0052	0.0036	0.00168
JUL 19,83	JUN 21,83	0.070	0.087	0.219	0.022	0.0068	0.0034	0.00176
AUG 16,83	JUL 19,83	0.041	0.068	0.123	0.019	0.0040	0.0046	< 0.00066
SEP 13,83	AUG 16,83	0.048	0.079	0.054	0.017	0.0042	0.0030	< 0.00060
OCT 11,83	SEP 13,83	0.081	0.044	0.025	0.017	0.0029	0.0017	< 0.00058
NOV 8,83	OCT 11,83	0.089	0.037	0.042	0.022	0.0024	0.0024	U 0.01363
DEC 6,83	NOV 8,83	0.099	0.024	0.014	0.014	< 0.0018	0.0029	< 0.00180
JAN 3,84	DEC 6,83	0.167	0.016	0.007	0.026	0.0019	0.0026	0.00103

REMOVAL DATE	EXPOSURE DATE	VANADIUM UG/M**3	ZINC UG/M**3	CADMIUM UG/M**3
FEB 1,83	JAN 4,83	< 0.0016	0.013	0.00019
MAR 1,83	FEB 1,83	< 0.0013	0.021	0.00059
MAR 29,83	MAR 1,83	< 0.0011	0.023	0.00060
APR 26,83	MAR 29,83	< 0.0011	0.009	0.00025
MAY 24,83	APR 26,83	< 0.0012	0.009	0.00027
JUN 21,83	MAY 24,83	< 0.0013	0.010	0.00054
JUL 19,83	JUN 21,83	< 0.0014	0.007	0.00016
AUG 16,83	JUL 19,83	< 0.0013	0.009	0.00053
SEP 13,83	AUG 16,83	< 0.0012	0.008	0.00033
OCT 11,83	SEP 13,83	< 0.0012	0.013	0.00041
NOV 8,83	OCT 11,83	< 0.0012	0.008	0.00041
DEC 6,83	NOV 8,83	< 0.0036	0.011	0.00029
JAN 3,84	DEC 6,83	< 0.0013	0.017	0.00115

Table 1. Event Site Location Descriptions

APIOS EVENT WET/DRY DEPOSITION NETWORK SITE LOCATIONS

AREA	MOE REGION	STATION NAME	INSTRUMENTATION	ELEVATION (m above MSL)	LATITUDE (North)	LONGITUDE (West)	UTM COORDINATES (Northing)	(Easting)
London	Southwestern	Longwoods	Wet and Dry	239	42°53'	81°29'	4747850	460700
		Melbourne	Wet	213	42°47'	81°33'	4736850	454600
		North Easthope	Wet	375	43°24'	80°53'	4805650	508650
		Wellesley	Wet	344	43°28'	80°46'	4812650	519500
Dorset	Central	Dorset	Wet and Dry	320	45°13'	78°56'	5009650	662400
		Nithgrove	Wet	325	45°12'	79°04'	5006800	651600
		Balsam Lake	Wet	259	44°38'	78°51'	4943400	670070
		Raven Lake	Wet	274	44°37'	78°54'	4941600	665750
Kingston	Southeastern	Charleston Lake	Wet and Dry	92	44°30'	76°03'	4927500	417150
		Graham Lake *	Wet	130	44°35'	75°52'	4936750	431450
		Railton	Wet	156	44°23'	76°36'	4914700	373200
		Whitman Creek *	Wet	137	44°29'	76°49'	4927200	355100
		Wilmer *	Wet	145	44°27'	76°32'	4921500	378250
Atikokan	Northwestern	Fernberg	Wet and Dry	506	47°50'	91°52'	5316000	585000
		Forbes Twsp. *	Wet	324	48°38'	89°37'	5388000	308000
		Quetico Centre	Wet	420	48°45'	91°12'	5399000	632000
		Lac La Croix *	Wet	368	48°21'	92°12'	5356000	558200
		Dawson	Wet	381	48° 34'	89° 39'	5380800	304700

* Whitman Creek removed Nov'84
Lac La Croix removed Mar'84
Wilmer installed Oct'85
Forbes removed Nov'86
Dawson installed Nov'86
Graham Lake removed Oct'86

Table 2. Cumulative Site Location Descriptions

APIOS CUMULATIVE WET/DRY DEPOSITION NETWORK SITE DESCRIPTIONS

MOE REGION	STATION NAME	STATION NUMBER	INSTRUMENTATION	ELEVATION (m above MSL)	LATITUDE (North)	LONGITUDE (West)	UTM GRID CO-ORDINATES (Northing)	(Easting)
Southwestern	Colchester	1041	MIC/Low-Volume Air	183	41°59'15"	82°55'41"	4650000	340300
	Merlin	1051	MIC	191	42°14'47"	82°13'30"	4676400	398950
	Pt. Stanley	1061	MIC/Low-Volume Air	213	42°40'22"	81°09'55"	4724050	486700
	Wilkesport	1071	MIC/Low-Volume Air	183	42°42'11"	82°21'13"	4728350	389150
	Alvinston	1081	MIC	221	42°49'36"	81°50'04"	4942000	431550
	Shallow Lake	1091	MIC/Low-Volume Air	229	44°34'54"	81°05'24"	4936200	492850
	Palmerston	1101	MIC/Low-Volume Air	389	43°48'19"	80°54'12"	4850050	507750
	Huron Park	1191	MIC	250	43°17'28"	81°30'03"	4793000	459350
	Waterloo	2021	MIC	343	43°28'39"	80°35'09"	4813750	533500
Central	Dorset	3011	MIC/Low-Volume Air	320	45°13'26"	78°55'52"	5009650	662400
	Milton	3051	MIC	221	43°31'05"	79°55'54"	4818600	586350
	Uxbridge	3061	MIC/Low-Volume Air	244	44°12'46"	79°12'38"	4896800	643000
	Wilberforce	3071	MIC	396	45°00'54"	78°12'58"	4988150	719400
	Campbellford	3081	MIC/Low-Volume Air	175	44°17'28"	77°47'33"	4907600	277150
	Coldwater	3101	MIC	280	44°37'31"	79°32'08"	4942200	615900
Southeastern	Kaladar	4051	MIC/Low-Volume Air	244	44°41'31"	77°09'18"	4950800	329250
	Smith's Falls	4061	MIC/Low-Volume Air	122	44°56'41"	75°57'48"	4977100	423950
	Dalhousie Mills	4071	MIC/Low-Volume Air	69	45°19'00"	74°28'13"	5018100	541550
	Golden Lake	4081	MIC/Low-Volume Air	160	45°36'48"	77°12'03"	5053200	328400
	Cloyne	4091	MIC/Low-Volume Air	259	44°49'09"	77°11'45"	4964750	327100
Northeastern	McKellar	5011	MIC/Low-Volume Air	244	45°30'57"	79°55'19"	5040600	583950
	Killarney	5021	MIC/Low-Volume Air	183	45°59'26"	81°29'18"	5092900	462200
	Mattawa	5031	MIC/Low-Volume Air	198	46°16'45"	78°49'19"	5127150	667800
	Bear Island	5041	MIC	305	46°58'22"	80°04'40"	5202400	570350
	Ramsey	5051	MIC	427	47°26"33"	82°20'14"	5254900	399200
	Gowganda	5061	MIC/Low-Volume Air	343	47°39'04"	80°46'32"	5277300	516600
	Moonbeam	5071	MIC/Low-Volume Air	244	49°19'16"	82°08'46"	5463600	416650
	Attawapiskat	5081	MIC/Low-Volume Air	9	52°56'00"	82°24'00"	NA	NA
	Whitney	5091	MIC	412	45°32'21"	78°15'35"	5045950	713950
	Turkey Lake	5141	MIC/Low-Volume Air	472	47°03'15"	84°24'00"	5214250	696750
	Azure Lake	5151	MIC	244	47°28'12"	81°52'30"	5257650	434250
	Moosonee	5161	MIC/Low-Volume Air	8	51°12'34"	80°42'20"	5673000	520550
Northwestern	Dorion	6011	MIC/Low-Volume Air	244	48°50'33"	88°36'45"	5410800	382150
	Nakina	6021	MIC/Low-Volume Air	320	50°10'38"	86°42'90"	5558150	520950
	Ear Falls	6031	MIC/Low-Volume Air	350	50°38'31"	93°13'13"	5609800	484150
	Pickle Lake	6041	MIC/Low-Volume Air	360	51°27'41"	90°12'04"	5704800	694550
	Lac la Croix	6061	MIC	368	48°21'14"	92°12'32"	5355900	558400
	Quetico Centre	6071	MIC/Low-Volume Air	420	48°44'24"	91°12'08"	5399750	632100
	E.L.A.	6091	MIC	123	49°39'22"	93°43'28"	5500950	447350
	Winisk	6101	MIC	9	55°12'00"	85°08'00"	NA	NA
	Otter Island	6111	MIC/Low-Volume Air	204	48°06'50"	86°04'25"	5328750	569500
	Geraldton	6121	MIC/Low-Volume Air	351	49°48'05"	86°46'00"	5516300	516750

Table 3.

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (EVENT NETWORK)
January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
1	Longwoods	000002	02	01	1011	Daily Wet Collector - Primary
		000002	02	01	1012	Daily Wet Collector - Secondary
		000002	21	21	1011	Daily Sequential Air Sampler
2	Melbourne	000002	02	01	1021	Daily Wet Collector
3	North Easthope	000002	02	01	1031	Daily Wet Collector
4	Wellesley	000002	02	01	2011	Daily Wet Collector - Primary
		000002	02	01	2012	Daily Wet Collector - Secondary
8	Dorset	000002	02	01	3011	Daily Wet Collector - Primary
		000002	02	01	3012	Daily Wet Collector - Secondary
		000002	21	21	3011	Daily Sequential Air Sampler - Primary
		000002	21	21	3012	Daily Sequential Air Sampler - Secondary
7	Nithgrove	000002	02	01	3021	Daily Wet Collector
6	Balsam Lake	000002	02	01	3031	Daily Wet Collector
5	Raven Lake	000002	02	01	3041	Daily Wet Collector
11	Charleston Lake	000002	02	01	4011	Daily Wet Collector
		000002	21	21	4011	Daily Sequential Air Sampler
10	Railton	000002	02	01	4021	Daily Wet Collector - Primary
		000002	02	01	4022	Daily Wet Collector - Secondary
12	Graham Lake	000002	02	01	4031	Daily Wet Collector*

*Instrument and/or Site removed

Table 3. (cont'd)

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (EVENT NETWORK) (Continued)

January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
9	Whitman Creek	000002	02	01	4041	Daily Wet Collector*
18	Wilmer	000002	02	01	4101	Daily Wet Collector
16	Fernberg	000002	02	01	6051	Daily Wet Collector
		000002	21	21	6051	Daily Sequential Air Sampler
15	Lac La Croix	000002	02	01	6061	Daily Wet Collector*
14	Quetico Centre	000002	02	01	6071	Daily Wet Collector
13	Forbes Township	000002	02	01	6081	Daily Wet Collector - Primary*
		000002	02	01	6082	Daily Wet Collector - Secondary*
17	Dawson	000002	02	01	6131	Daily Wet Collector - Primary
		000002	02	01	6132	Daily Wet Collector - Secondary

*Instrument and/or site removed

Table 4.

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (CUMULATIVE NETWORK)
January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
1	Colchester	000001	01	01	1041	Cumulative (28-Day) Wet Collector
		000001	22	21	1041	Cumulative (28-Day) Lo-Vol Air Sampler
2	Merlin	000001	01	01	1051	Cumulative (28-Day) Wet Collector
3	Port Stanley	000001	01	01	1061	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	1062	Cumulative (28-Day) Wet Collector - Secondary*
		000001	22	21	1061	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	1062	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary*
4	Wilkesport	000001	01	01	1071	Cumulative (28-Day) Wet Collector
		000001	22	21	1071	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	1072	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary
5	Alvinston	000001	01	01	1081	Cumulative (28-Day) Wet Collector
9	Shallow Lake	000001	01	01	1091	Cumulative (28-Day) Wet Collector
		000001	22	21	1091	Cumulative (28-Day) Lo-Vol Air Sampler
8	Palmerston	000001	01	01	1101	Cumulative (28-Day) Wet Collector
		000001	22	21	1101	Cumulative (28-Day Lo-Vol Air Sampler
6	Huron Park	000001	01	01	1191	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	1192	Cumulative (28-Day) Wet Collector - Secondary
7	Waterloo	000001	01	01	2021	Cumulative (28-Day) Wet Collector
20	Dorset	000001	01	01	3011	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	3012	Cumulative (28-Day) Wet Collector - Secondary
		000001	22	21	3011	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	3012	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary

* Site and/or Instrument removed

Table 4. (cont'd)

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (CUMULATIVE NETWORK) (Continued)

January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
10	Milton	000001	01	01	3051	Cumulative (28-Day) Wet Collector*
		000001	22	21	3051	Cumulative (28-Day) Lo-Vol Air Sampler*
11	Uxbridge	000001	01	01	3061	Cumulative (28-Day) Wet Collector
		000001	22	21	3061	Cumulative (28-Day) Lo-Vol Air Sampler
18	Wilberforce	000001	01	01	3071	Cumulative (28-Day) Wet Collector
13	Campbellford	000001	01	01	3081	Cumulative (28-Day) Wet Collector
		000001	22	21	3081	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	3082	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary
12	Coldwater	000001	01	01	3101	Cumulative (28-Day) Wet Collector
15	Smith's Falls	000001	01	01	4061	Cumulative (28-Day) Wet Collector
		000001	22	21	4061	Cumulative (28-Day) Lo-Vol Air Sampler
16	Dalhousie Mills	000001	01	01	4071	Cumulative (28-Day) Wet Collector
		000001	22	21	4071	Cumulative (28-Day) Lo-Vol Air Sampler
17	Golden Lake	000001	01	01	4081	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	4082	Cumulative (28-Day) Wet Collector - Secondary
		000001	22	21	4081	Cumulative (28-Day) Lo-Vol Air Sampler
14	Cloyne	000001	01	01	4091	Cumulative (28-Day) Wet Collector
		000001	22	21	4091	Cumulative (28-Day) Lo-Vol Air Sampler
21	McKellar	000001	01	01	5011	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	5012	Cumulative (28-Day) Wet Collector - Secondary*
		000001	22	21	5011	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	5012	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary*

*Site and/or Instrument removed

Table 4. (cont'd)

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (CUMULATIVE NETWORK) (Continued)

January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
23	Killarney	000001	01	01	5021	Cumulative (28-Day) Wet Collector
		000001	22	21	5021	Cumulative (28-Day) Lo-Vol Air Sampler
22	Mattawa	000001	01	01	5031	Cumulative (28-Day) Wet Collector
		000001	22	21	5031	Cumulative (28-Day) Lo-Vol Air Sampler
24	Bear Island	000001	01	01	5041	Cumulative (28-Day) Wet Collector
25	Gowganda	000001	01	01	5061	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	5062	Cumulative (28-Day) Wet Collector - Secondary
		000001	22	21	5061	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	5062	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary
27	Moonbeam	000001	01	01	5071	Cumulative (28-Day) Wet Collector
		000001	22	21	5071	Cumulative (28-Day) Lo-Vol Air Sampler
28	Attawapiskat	000001	01	01	5081	Cumulative (28-Day) Wet Collector*
		000001	22	21	5081	Cumulative (28-Day) Lo-Vol Air Sampler*
19	Whitney	000001	01	01	5091	Cumulative (28-Day) Wet Collector
37	Turkey Lake	000001	01	01	5141	Cumulative (28-Day) Wet Collector
		000001	22	21	5141	Cumulative (28-Day) Lo-Vol Air Sampler
38	Moosonee	000001	01	01	5161	Cumulative (28-Day) Wet Collector
		000001	22	21	5161	Cumulative (28-Day) Lo-Vol Air Sampler
26	Azure Lake	000001	01	01	5151	Cumulative (28-Day) Wet Collector

Table 4. (cont'd)

APIOS STATION IDENTIFICATION CODES & DESCRIPTIONS (CUMULATIVE NETWORK) (Continued)

January, 1987

Map Reference Number	Station Name	Station Identifier: Collection Period	Instrument	Sample Type	Station Number	Description
31	Dorion	000001	01	01	6011	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	6012	Cumulative (28-Day) Wet Collector - Secondary
		000001	22	21	6011	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	6012	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary*
35	Ear Falls	000001	01	01	6031	Cumulative (28-Day) Wet Collector
		000001	22	21	6031	Cumulative (28-Day) Lo-Vol Air Sampler
36	Pickle Lake	000001	01	01	6041	Cumulative (28-Day) Wet Collector
		000001	22	21	6041	Cumulative (28-Day) Lo-Vol Air Sampler
33	Lac La Croix	000001	01	01	6061	Cumulative (28-Day) Wet Collector
32	Quetico Centre	000001	01	01	6071	Cumulative (28-Day) Wet Collector
34	E.L.A.	000001	01	01	6091	Cumulative (28-Day) Wet Collector
29	Winisk	000001	01	01	6101	Cumulative (28-Day) Wet Collector*
39	Otter Island	000001	01	01	6111	Cumulative (28-day) Wet Collector
		000001	22	21	6111	Cumulative (28-Day) Lo-Vol Air Sampler
30	Geraldton	000001	01	01	6121	Cumulative (28-Day) Wet Collector - Primary
		000001	01	01	6122	Cumulative (28-Day) Wet Collector - Secondary*
		000001	22	21	6121	Cumulative (28-Day) Lo-Vol Air Sampler - Primary
		000001	22	21	6122	Cumulative (28-Day) Lo-Vol Air Sampler - Secondary

*Site and/or Instrument removed

Table 4. cont'd

SPECIAL STUDIES STATION IDENTIFICATION CODES & DESCRIPTIONS (CUMULATIVE NETWORK)

Janaury, 1987

Station Name	Collection Period	Station Identifier: Instrument	Station Identifier: Sample Type	Station Identifier: Station Number	Description
Dog's Nest East	000001	01	01	1111	NEMP Cumulative (28-Day) Wet Collector
South Canfield	000001	01	01	1121	NEMP Cumulative (28-Day) Wet Collector*
Villa Nova	000001	01	01	1131	NEMP Cumulative (28-Day) Wet Collector*
Canborough	000001	01	01	1141	NEMP Cumulative (28-Day) Wet Collector*
North Dufferin	000001	01	01	1151	NEMP Cumulative (28-Day) Wet Collector
Bin Brook	000001	01	01	1161	NEMP Cumulative (28-Day) Wet Collector*
Germain Park	000001	01	01	1171	APIOS Cumulative (28-Day) Wet Collector*
Mt. Forest	000001	01	01	1181	APIOS Cumulative (28-Day) Wet Collector*
Burwash	000001	01	01	5101	APIOS Cumulative (28-Day) Wet Collector
Lively	000001	01	01	5111	APIOS Cumulative (28-Day) Wet Collector
Hanmer	000001	01	01	5121	APIOS Cumulative (28-Day) Wet Collector*
Rapide-des-Joachims, Que.	000001	01	01	5131	APIOS Cumulative (28-Day) Wet Collector*
Fernberg, Minn.	000001	01	01	6051	APIOS Cumulative (28-Day) Wet Collector*
McFarlane Lake	000001	01	01	5201	APIOS Cumulative (28-Day) Wet Collector
Hanmer #2	000001	01	01	5211	APIOS Cumulative (28-Day) Wet Collector
Sutton, Que.	000001	01	01	7011	APIOS Cumulative (28-Day) Wet Collector

*Site and/or Instrument removed

Table 5

DAILY WET DEPOSITION NETWORK LABORATORY ANALYSES

PARAMETER	ANALYSIS METHOD	DETECTION LIMIT ($mg l^{-1}$)
pH (for Hf* determination)	Radiometer pH meter and Ingold low-conductivity combination pH electrode	0.01 pH units
Gran Acidity (for Ht+ determination)	Gran titration: NaOH titration to a series of inflection points; results presented as $\mu g l^{-1}$ as H^+	0.001
Conductivity	Radiometer conductivity cell and meter	0.2 µmho (0-100 µmho)
$SO_4=$	Ion Chromatography	0.05
$N\text{-}NO_3-$	Ion Chromatography	0.01
Cl^-	Ion Chromatography	0.01
$N\text{-}NH_4+$	Automated phenate-hypochlorite method	0.005
Ca^{++}	Flame Atomic Absorption	0.02
Na^+	Flame Atomic Absorption	0.005
K^+	Flame Atomic Absorption	0.005
Mg^{++}	Flame Atomic Absorption	0.005

* Hf - free hydrogen ion concentration

+ Ht - total hydrogen ion concentration

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Table 6

DAILY DRY DEPOSITION NETWORK LABORATORY ANALYSES

PARAMETER	FILTER TYPE	EXTRACTION METHOD	ANALYSIS METHOD	DETECTION LIMIT (μg filter $^{-1}$)
$SO_4^=$	Teflon	20 minute ultrasonic bath in 25 ml distilled deionized water	Ion Chromatography	1.0
$N\text{-}NO_3^-$	Teflon	same as above	Ion Chromatography	.25
$N\text{-}NH_4^+$	Teflon	same as above	Automated Phenate-Hypochlorite Colorimetry	.10
$N\text{-}HNO_3$	Nylon	20 minute ultrasonic bath in 25 ml x 10^{-3}N NaOH	Ion Chromatography (as NO_3^-)	0.25
$SO_4^=$	Nylon	20 minute ultrasonic bath in 25 ml x 10^{-3}N NaOH	Ion Chromatography (as $SO_4^=$)	1.00
SO_2	Impregnated Whatman 41 Cellulose	60 minute shaking in 50 ml 0.05% (v/v) hydrogen peroxide; followed by 20 minute ultrasonic bath.	Ion Chromatography (as $SO_4^=$)	1.00

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Table 7
APIOS CUMULATIVE WET SAMPLE LABORATORY ANALYSES

PARAMETER	ANALYSIS METHOD	DETECTION LIMIT ($mg\ l^{-1}$)
pH (for Hf* determination)	Radiometer pH meter and Ingold low-conductivity combination pH electrode	0.01 pH units
Gran Acidity (for Ht^+ determination)	Gran titration: NaOH titration to a series of inflection points; results presented as $\mu g\ l^{-1}$ as H+	0.001
Conductivity	Radiometer conductivity cell and meter	0.2 us/cm
$SO_4=$	Ion Chromatography	0.05
$N\text{-}NO_3^-$	Ion Chromatography	0.01
Cl^-	Ion Chromatography	0.01
$N\text{-}NH_4^+$	Automated phenate-hypochlorite colorimetry	0.005
CA^{++}	Flame Atomic Absorption	0.02
Na^+	Flame Atomic Absorption	0.005
K^+	Flame Atomic Absorption	0.005
Mg^+	Flame Atomic Absorption	0.005
N-TKN	Automated phenate-hypochlorite colorimetry	0.02
TP	Ammonium molybdate-ascorbic acid colorimetry	0.002
Zn	Flameless Atomic Absorption	0.001
Fe	Flameless Atomic Absorption	0.001
Ni	Flameless Atomic Absorption	0.0002
Cu	Flameless Atomic Absorption	0.0002
Pb	Flameless Atomic Absorption	0.001
Al	Flameless Atomic Absorption	0.005
Cd	Flameless Atomic Absorption	0.00002
Mn	Flameless Atomic Absorption	0.001
V	Flameless Atomic Absorption	0.0004

*Hf - Free hydrogen ion concentration
+Ht - total hydrogen ion concentration

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Table 8

APIOS CUMULATIVE LOW-VOLUME AIR FILTER LABORATORY ANALYSES

PARAMETER	FILTER TYPE	EXTRACTION METHOD	ANALYSIS METHOD	DETECTION LIMIT (μg filter $^{-1}$)
Cl^-	Whatman 40	20 minute ultrasonic bath in 50 ml DDW	Ion Chromatography	0.50
Ca^{++}	Whatman 40	See Zn	Inductively Coupled Plasma	1.0
Mg^{++}	Whatman 40	See Zn	Inductively Coupled Plasma	0.025
Na^+	Whatman 40	20 minute ultrasonic bath in 50 ml DDW	Atomic Absorption Spectrophotometry	0.250
K^+	Whatman 40	Same as above	Atomic Absorption Spectrophotometry	0.250
$N\text{-}HNO_3$	Nylon	20 minute ultrasonic bath in 25 ml 3×10^{-3} N NaOH	Ion Chromatography (as NO_3^-)	0.25
$SO_4=$	Nylon	Same as above	Ion Chromatography (as $SO_4=$)	1.0
SO_2	Whatman 41	60 minute shaking in 50 ml 0.05% (v/v) hydrogen peroxide; followed by 20 minute ultrasonic treatment.	Ion Chromatography (as $SO_4=$)	1.00

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Table 8 (Cont'd)

APIOS CUMULATIVE LOW-VOLUME AIR FILTER LABORATORY ANALYSES

PARAMETER	FILTER TYPE	EXTRACTION METHOD	ANALYSIS METHOD	DETECTION LIMIT ($\mu g\ filter^{-1}$)
Zn	Whatman 40	20 minute ultrasonic bath in 50 ml deionized/distilled water followed by oven digestion in 5% HNO_3	Atomic Absorption Graphite Furnace	0.050
Fe	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.050
Ni	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.010
Cu	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.010
Pb	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.050
Al	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.250
Cd	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.001
Mn	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.050
V	Whatman 40	Same as above	Atomic Absorption Graphite Furnace	0.020
$SO_4^=$	Whatman 40	20 minute ultrasonic bath in 50 ml DDW	Ion Chromatography	2.00
$N\text{-}NO_3$	Whatman 40	Same as above	Ion Chromatography	0.50

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